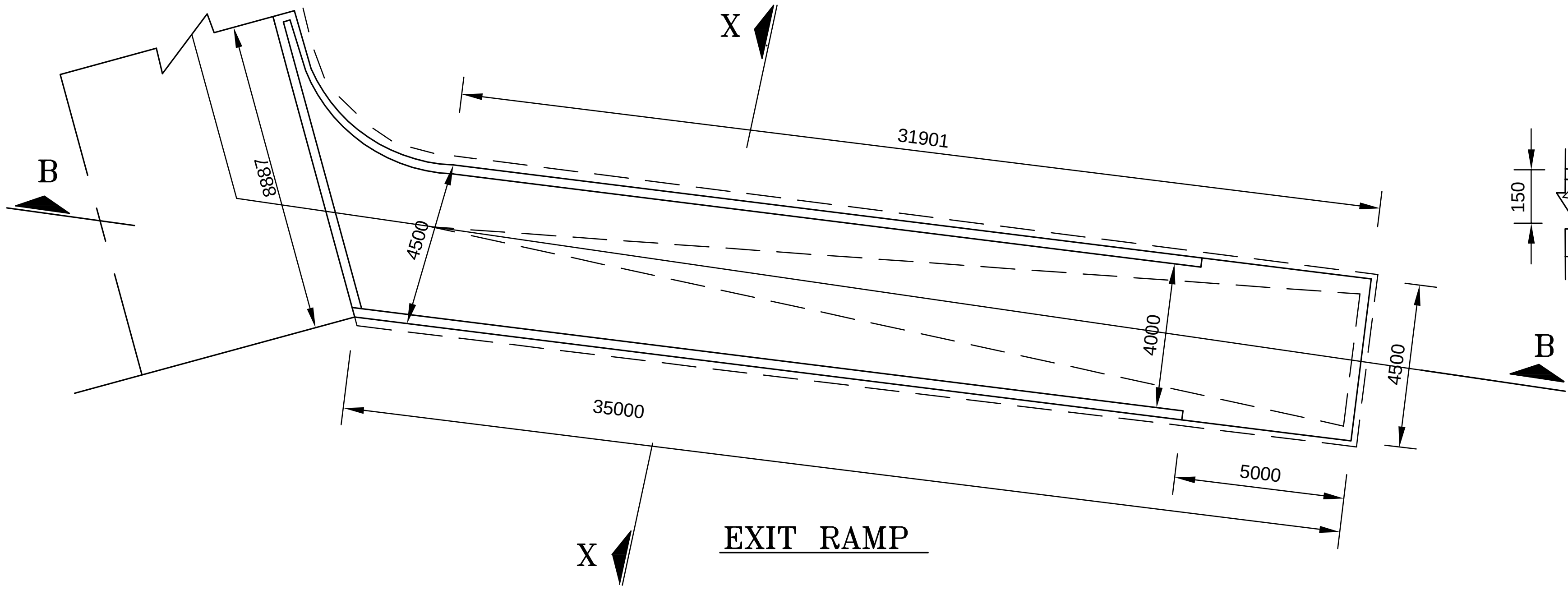
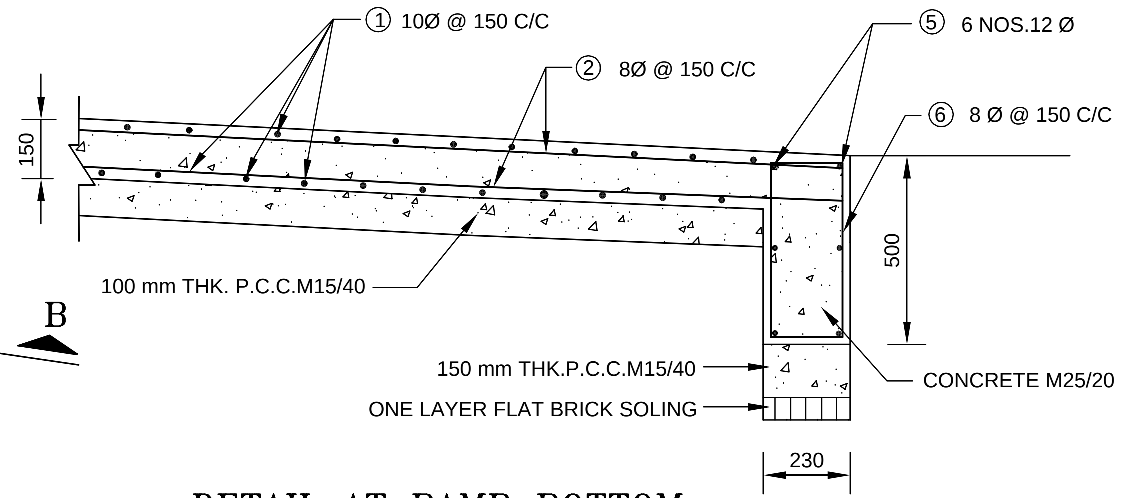
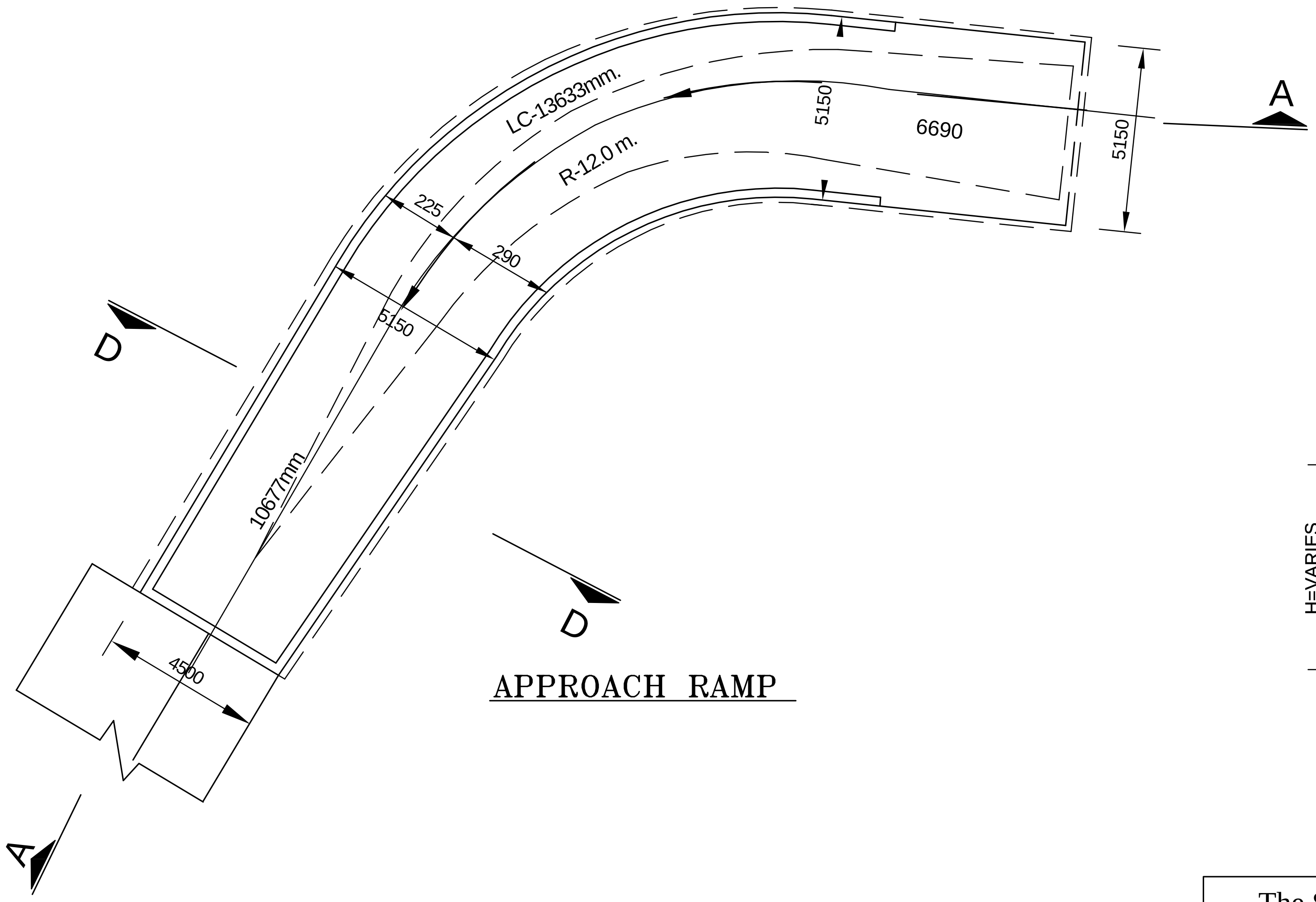


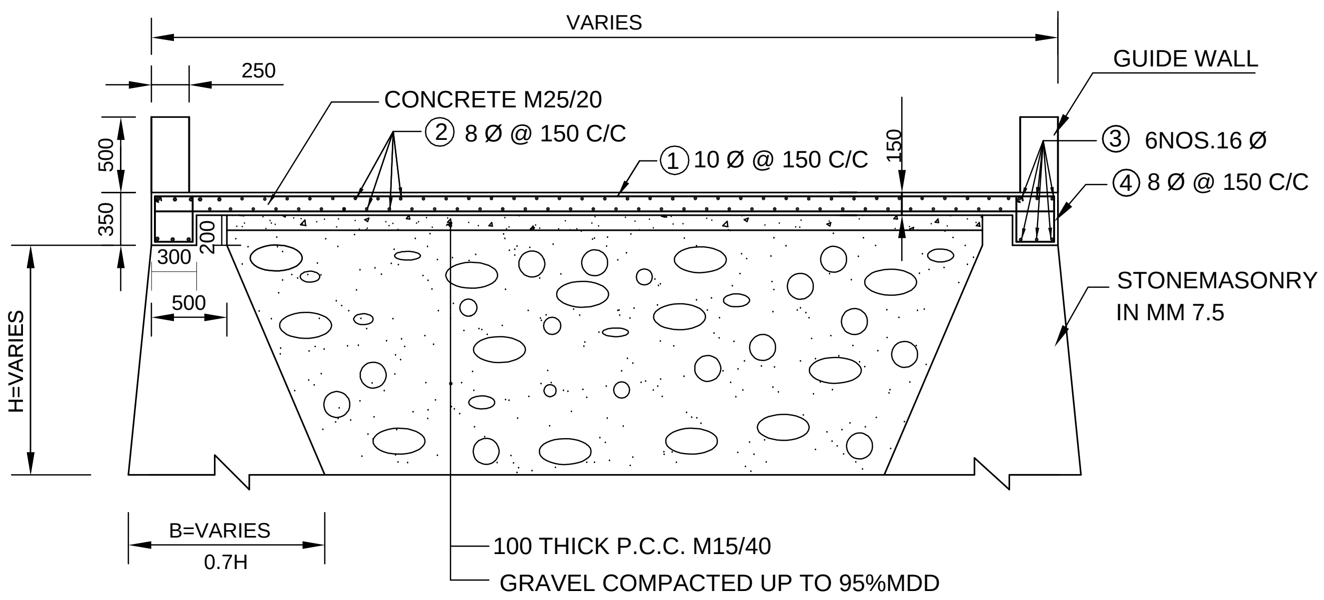
EXIT RAMP



DETAIL AT RAMP BOTTOM

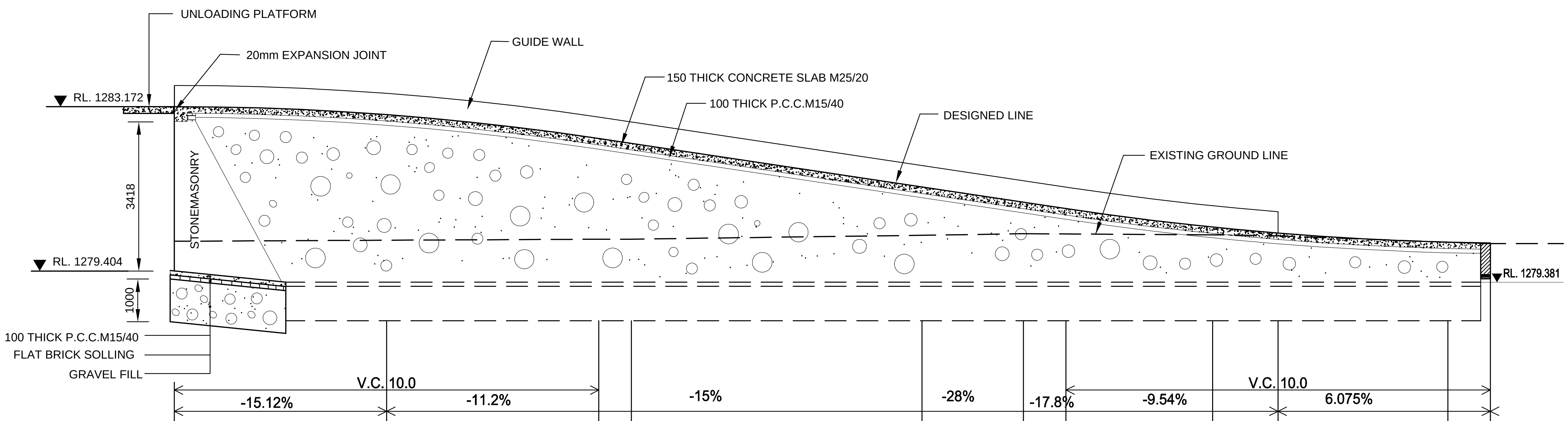


APPROACH RAMP



TYPICAL RAMP CROSS SECTION D-D AND X-X

The Study on the Solid Waste Management for the Kathmandu Valley	**Figure A.2-17** **Ramp Detail** **Ramps of Unloading Platform**
Japan International Cooperation Agency	

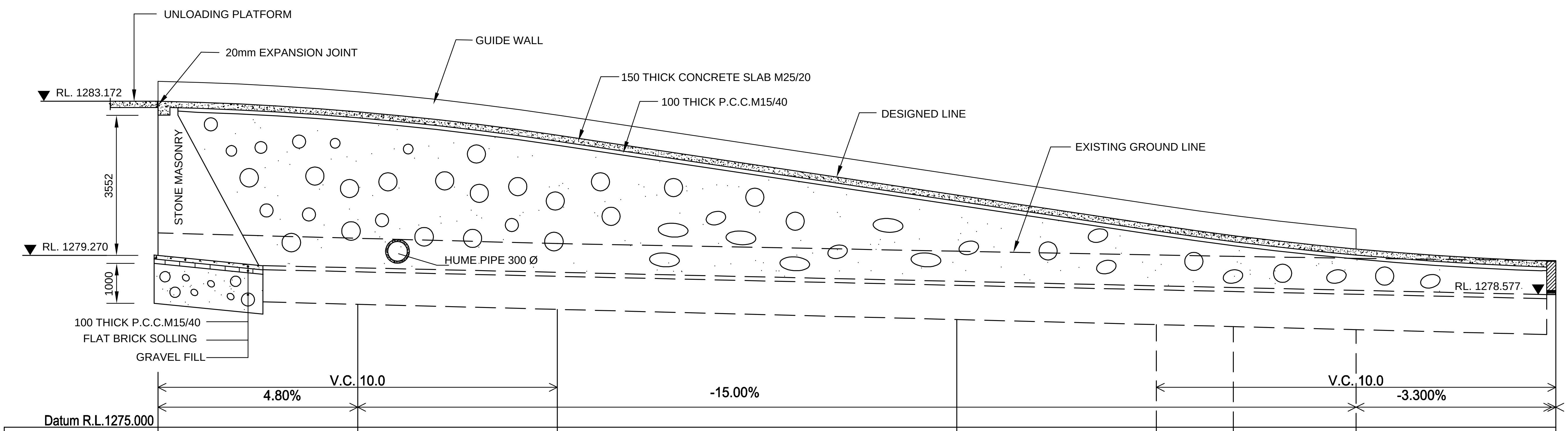


Datum R.L.1275.00

Top Surface	1283.166	1282.992	1282.432		1281.283	1281.953	1280.775		1280.298	1280.055	1280.048
Natural Surface	1280.004		1280.052	1280.053	1280.145	1280.180		1280.156	1280.132	1279.981	
CHAINAGE	0.00	5.00	10.00	10.77	17.61	20.00	21.00	24.46	26.00	30.00	31.00

LONGITUDINAL SECTION A-A

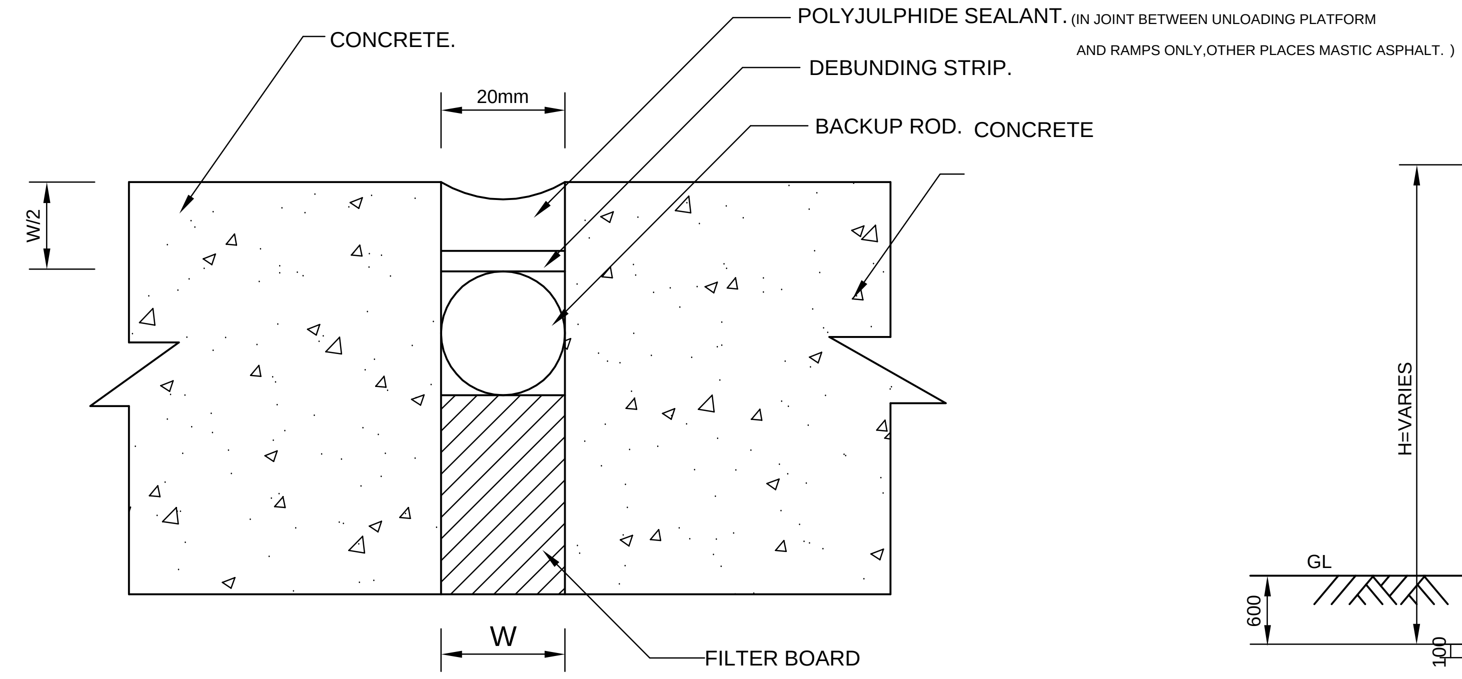
The Study on the Solid Waste Management for the Kathmandu Valley	**Figure A.2-18**
Japan International Cooperation Agency	**Longitudanal Section of Approach Ramp Ramps of Unloading Platform**



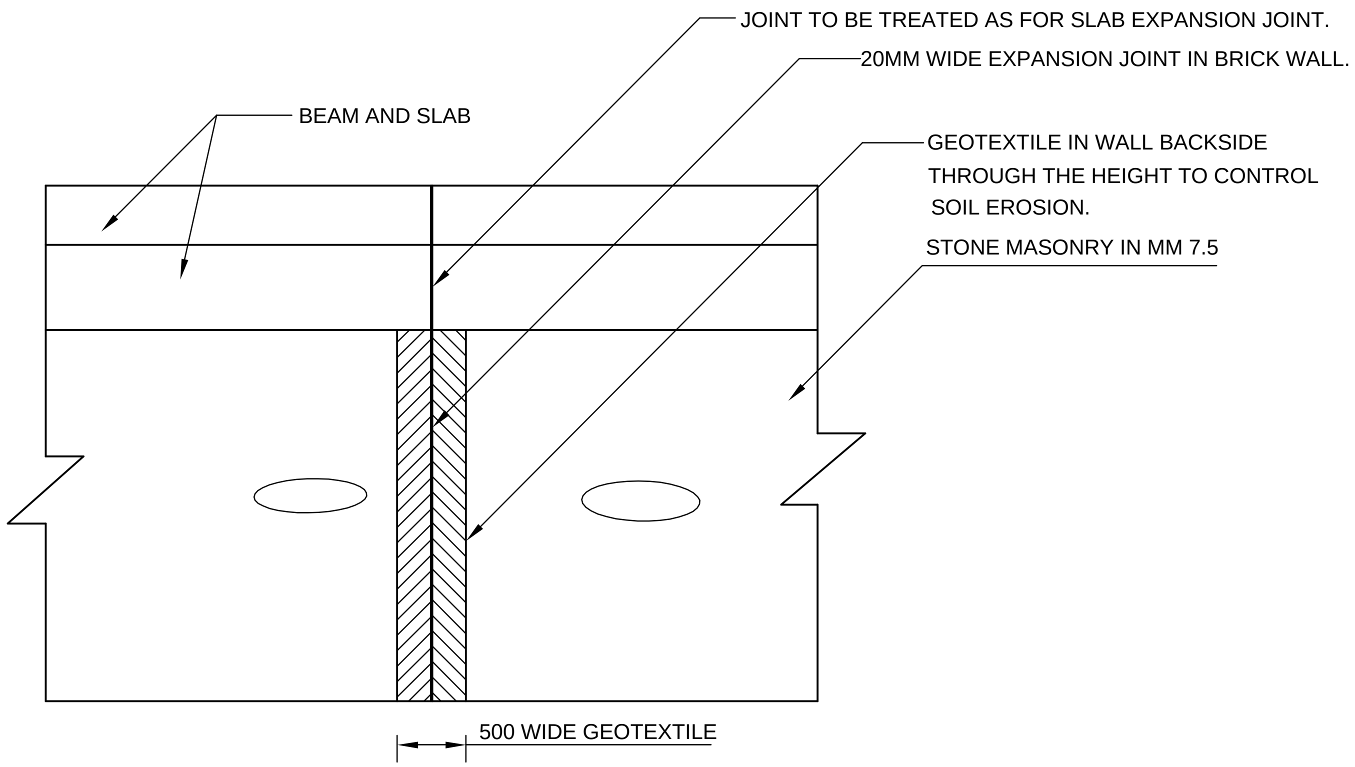
Top Surface	1283.142	1282.902	1282.320	1280.82	1280.070		1279.466	1279.156
Natural Surface	1279.870		1279.603	1279.413		1279.283	1279.233	1279.177
CHAINAGE	0.00	5.00	10.00	20.00	25.00	26.92	30.00	35.00

LONGITUDINAL SECTION B-B

The Study on the Solid Waste Management for the Kathmandu Valley	**Figure A.2-19** **Longitudinal Section of Exit Ramp Ramps of Unloading Platform**
Japan International Cooperation Agency	

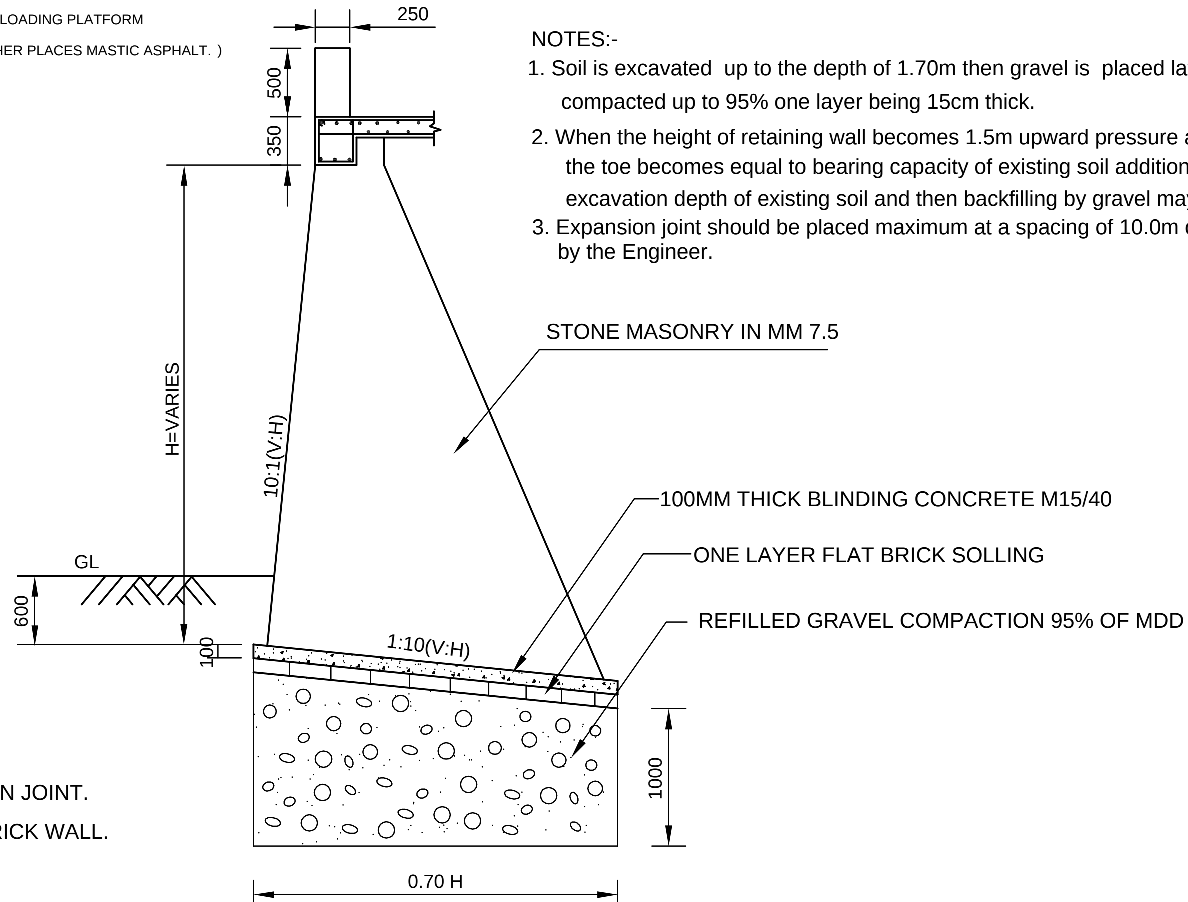


SLAB EXPANSION JOINT DETAILS
NOT TO SCALE

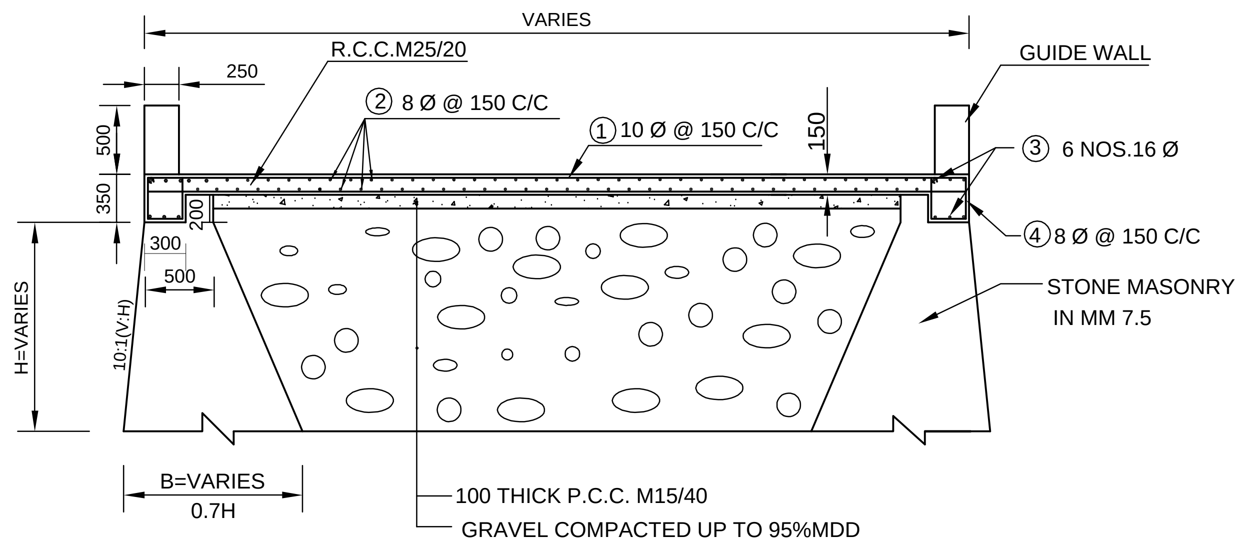


WALLS EXPANSION JOINT DETAILS

NOTES:-
1. Soil is excavated up to the depth of 1.70m then gravel is placed layerwise and then compacted up to 95% one layer being 15cm thick.
2. When the height of retaining wall becomes 1.5m upward pressure at the toe becomes equal to bearing capacity of existing soil additional excavation depth of existing soil and then backfilling by gravel may not be nceccessary.
3. Expansion joint should be placed maximum at a spacing of 10.0m or as directed by the Engineer.



STONE MASONRY WALL



TYPICAL RAMP CROSS SECTION D-D AND X-X

The Study on the Solid Waste Management for the Kathmandu Valley	**Figure A.2-20** **Ramp Section And Expantion Detail Ramps for Unloading Platform**
Japan International Cooperation Agency	

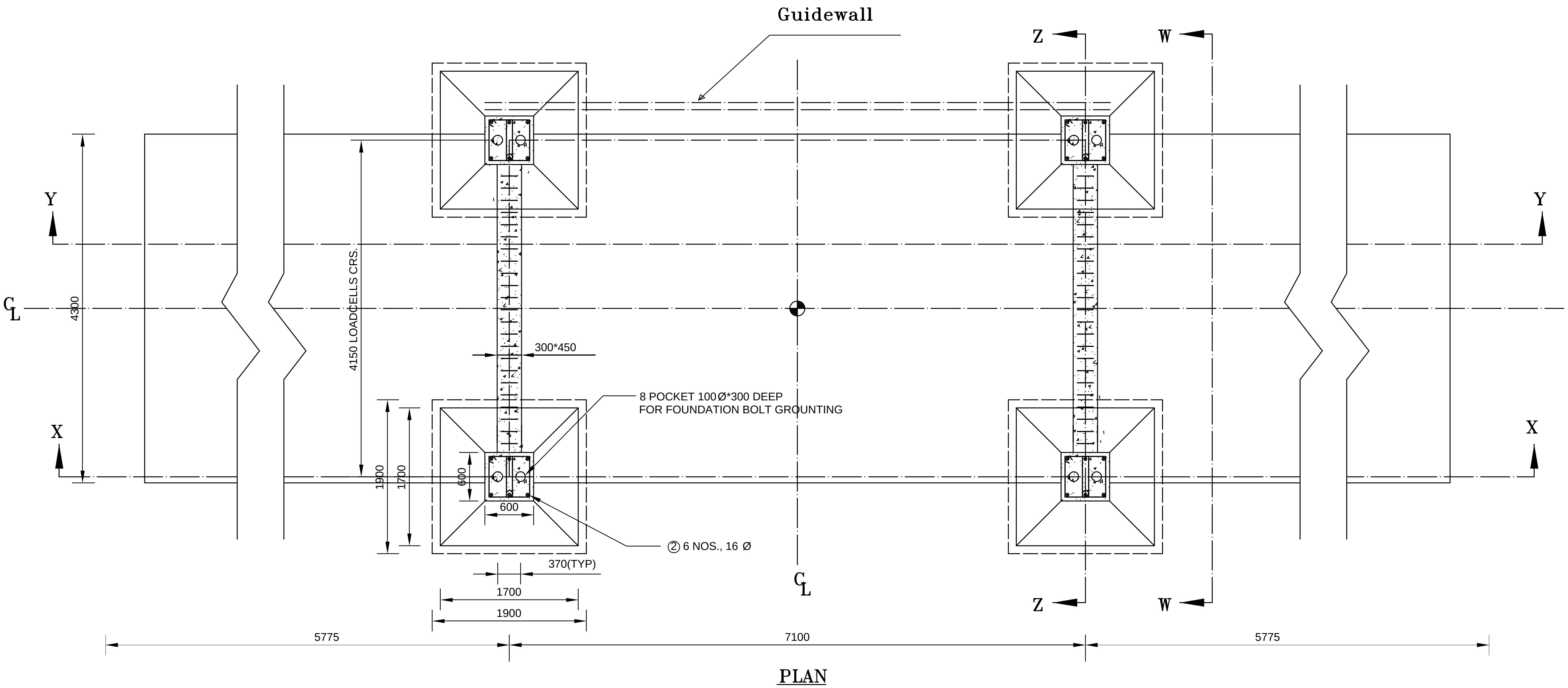
BAR BENDING SCHEDULE (APPROACH RAMP)

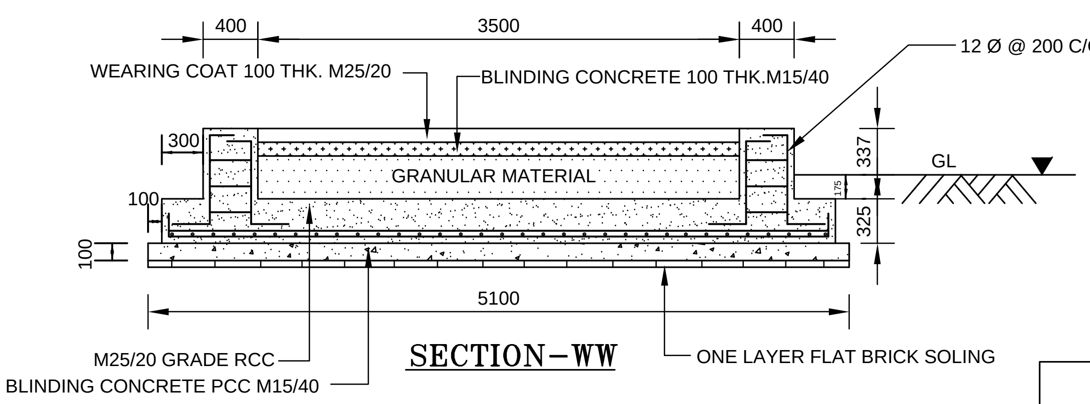
S. No.	Bar Mark	Bar Shape	Dia (mm)	No. of Bars	Length of each bar (m)	Total Length (m)	Unit Weight (kg/m)	Total Weight (kgs)	Remarks
1	1	90 5050 90	10	208	5.33	1087.84	0.62	674.461	DRG. NO. 18,21
2	2	72 30900 72	8	35	31.044	1086.54	0.395	429.183	
3	3	144 28600 144	16	6	28.888	173.328	1.578	273.512	
4	3	144 22950 144	16	6	23.238	139.428	1.578	220.017	
5	3	144 8787 144	16	6	9.075	4.688	1.578	7.398	
6	4	80 250 200	8	346	10.60	3667.60	0.395	1448.702	
7	4	80 250 200	8	30	1.06	31.80	0.395	12.561	
8	5	108 5050 108	12	6	5.266	31.596	0.888	28.057	
9	6	80 140 130	8	35	1.22	42.70	0.395	16.867	
			Sub Total					3110.00	
			Grand Total					3110.00	

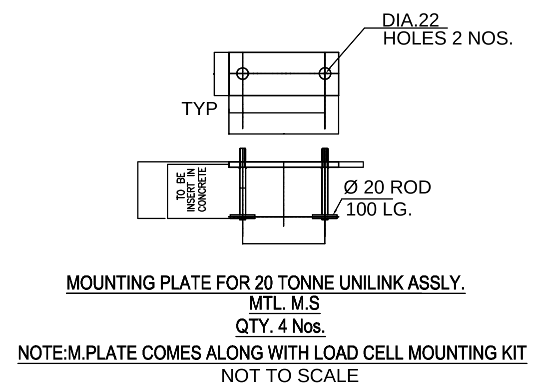
BAR BENDING SCHEDULE (EXIT RAMP)

S. No.	Bar Mark	Bar Shape	Dia (mm)	No. of Bars	Length of each bar (m)	Total Length (m)	Unit Weight (kg/m)	Total Weight (kgs)	Remarks
1	1	90 4400 90	10	233	4.58	1067.14	0.62	661.627	DRG. NO. 18,21
2	2	72 34900 72	8	30	35.044	1051.32	0.395	415.27	
3	3	144 35800 144	16	6	36.088	216.528	1.578	341.681	
4	3	144 34900 144	16	6	34.264	205.584	1.578	324.412	
5	3	144 8787 144	16	6	9.075	54.45	1.578	85.922	
6	4	80 250 200	8	467	10.60	4950.20	0.395	1955.329	
7	4	80 250 200	8	60	1.06	63.60	0.395	25.122	
8	5	144 8787 144	12	6	4.616	27.696	0.888	24.594	
9	6	80 400 130	8	30	1.22	36.60	0.395	14.457	
			Sub Total					3850.00	
			Grand Total					3850.00	

Figure A.2-21
Bar Bending Schedule Of Approach And Exit Ramps for Unloading Platform



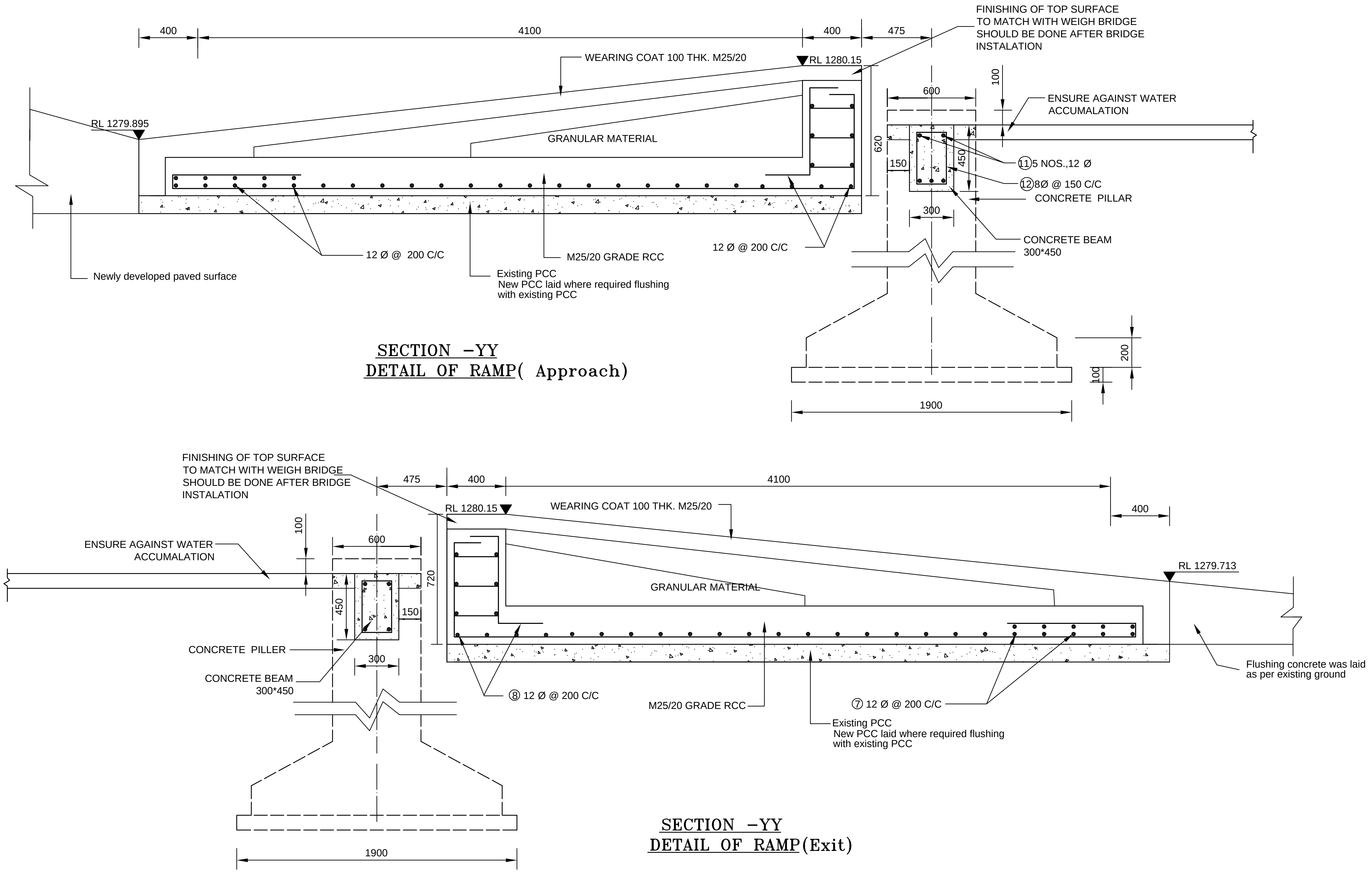




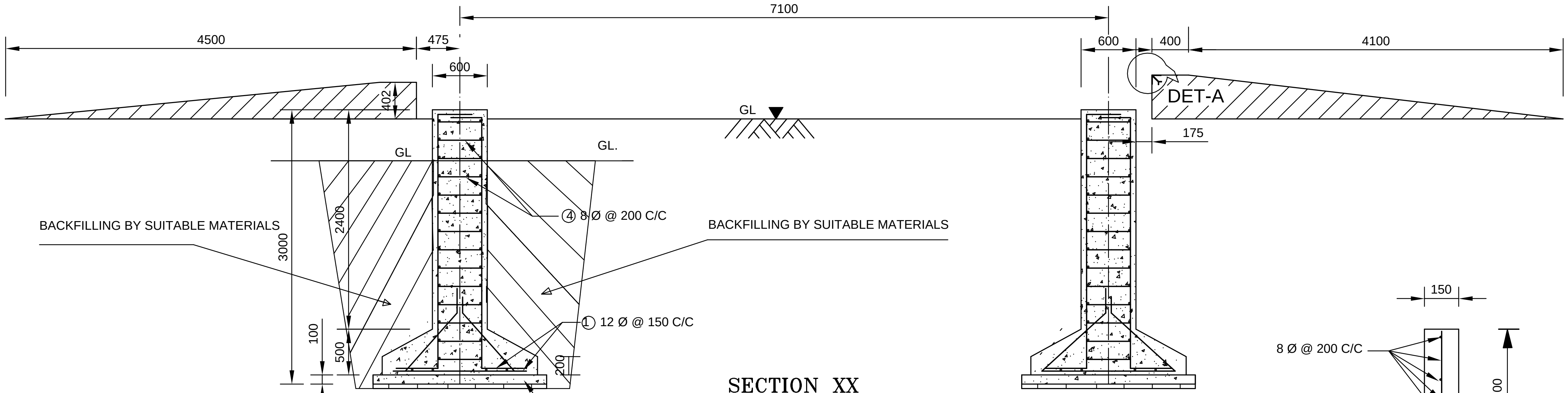
The Study on the Solid Waste Management for the Kathmandu Valley

Japan International Cooperation Agency

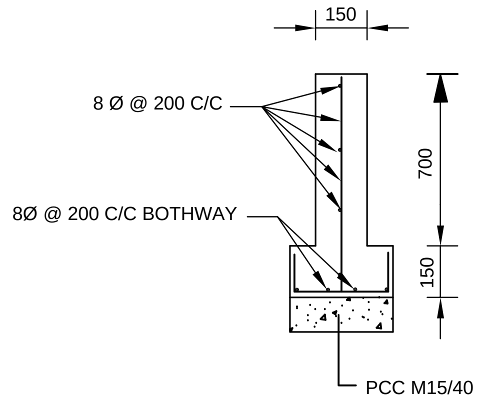
Figure A.2-22A
Plan And Section of Weighbridge
Weighbridge



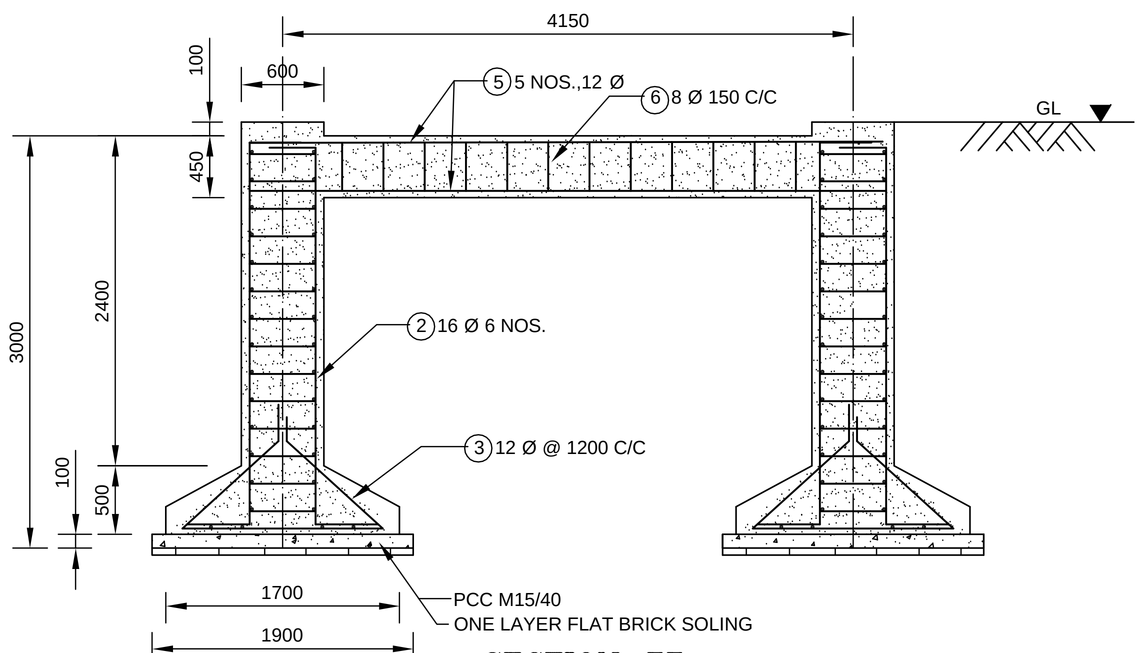
The Study on the Solid Waste Management for the Kathmandu Valley	**Figure A.2-22B Section Detail of Weighbridge Weighbridge**
Japan International Cooperation Agency	



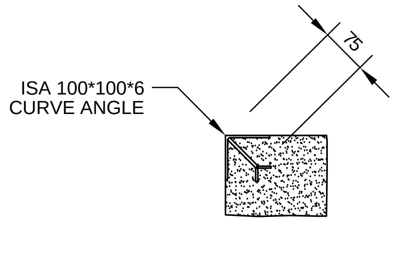
SECTION XX



GUIDE WALL FOR WEIGHT BRIDGE



SECTION–ZZ



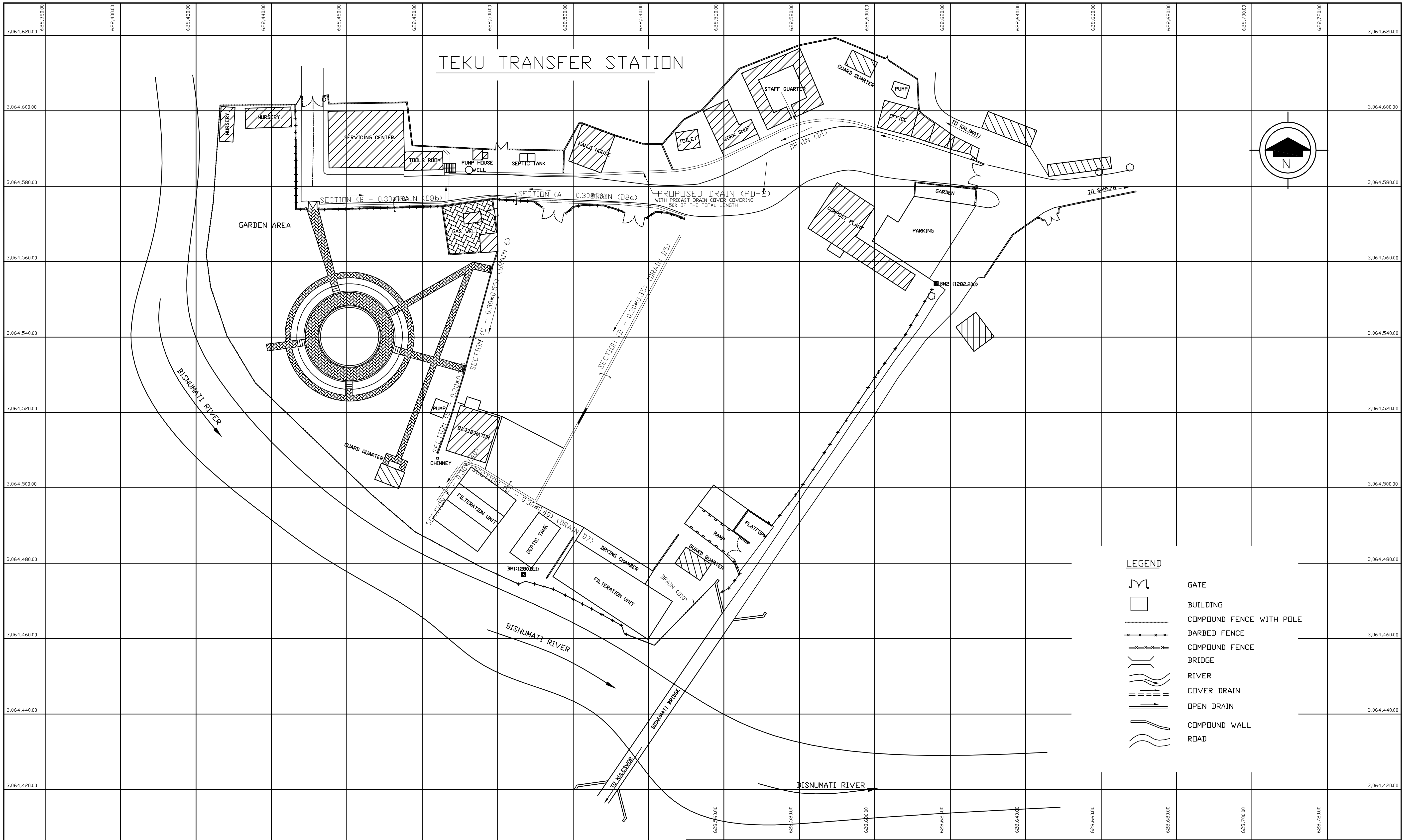
DETAIL A
NOT TO SCALE

The Study on the Solid Waste Management for the Kathmandu Valley	**Figure A.2-22C Section Detail of Weighbridge Weighbridge**
Japan International Cooperation Agency	

BAR BENDING SCHEDULE (WEIGH BRIDGE)

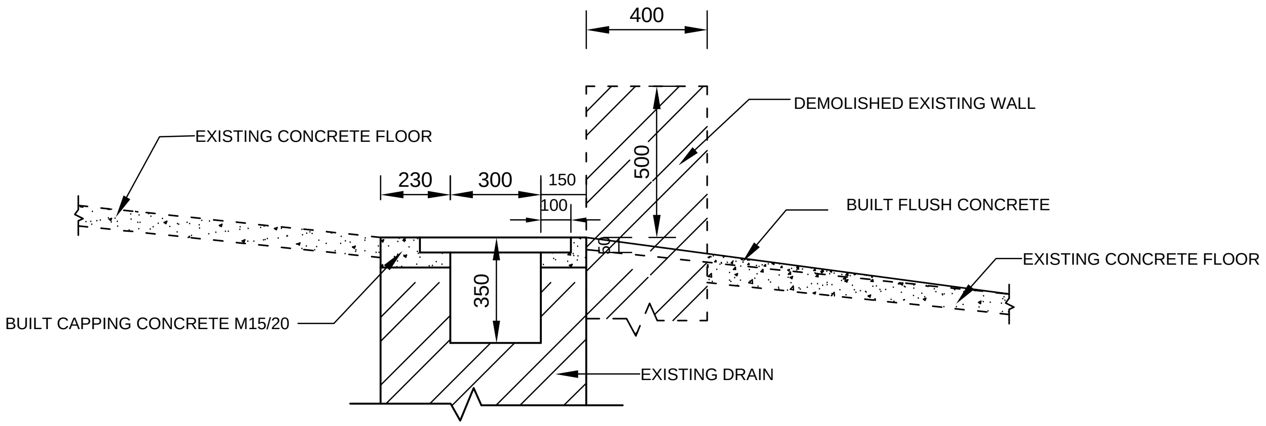
S. No.	Bar Mark	Bar Shape	Dia (mm)	No. of Bars	Length of each bar (m)	Total Length (m)	Unit Weight (kg/m)	Total Weight (kgs)	Remarks
1	1	108 1600 108	12	96	1.86	178.560	0.888	158.561	
2	2	455 2780 375	16	32	3.61	115.520	1.578	182.291	VIRTICAL
3	3	850 266	12	16	1.116	17.856	0.888	15.856	
4	4	80 500 500	8	64	1.58	101.120	0.395	39.942	
5	4	80 355 355	8	64	2.16	138.240	0.395	54.605	
6	5	108 4650 108	12	5	4.866	24.330	0.888	21.605	
7	6	80 350 200	8	50	1.26	63.00	0.395	24.885	
8	7	108 4800 108	12	22	5.016	110.352	0.888	97.992	Exit
9	8	92 490 4700 300 610	12	18	6.192	111.456	0.888	98.973	
10	7	300 610 300	12	21*2	1.21	50.82	0.888	45.128	
11	8	300 610 600	12	60	1.51	90.60	0.888	80.453	
12	9	108 4400 108	12	2*2	4.616	18.464	0.888	16.396	
13	10	108 3500 108	12	2*2	3.716	14.864	0.888	13.199	
14		108 4200 108	12	4	4.416	17.664	0.888	15.668	
15		108 4800 108	12	22	5.016	110.352	0.888	97.992	Approach
16		92 490 4700 300 520	12	18	6.102	109.836	0.888	97.534	
		300 520 300	12	21*2	1.12	47.04	0.888	41.772	
17		300 520 600	12	60	1.42	85.20	0.888	75.657	
18		108 4400 108	12	2*2	4.616	18.464	0.888	16.396	
19		108 3500 108	12	2*2	3.716	14.864	0.888	13.199	
20		108 4200 108	12	4	4.416	17.664	0.888	15.668	
21		75 7600 75	12	4	7.75	31	0.888	27.528	Guide wall
22		75 600 75	12	39	.750	29.25	0.888	25.974	
23		800 300	12	39	1.1	42.9	0.888	38.095	
24		70 7600 70	12	5	7.74	38.70	0.888	34.366	
			Sub Total					1358.735	
			Grand Total					1358.735	

Figure A.2-23
Bar Bending Schedules
Weighbridge

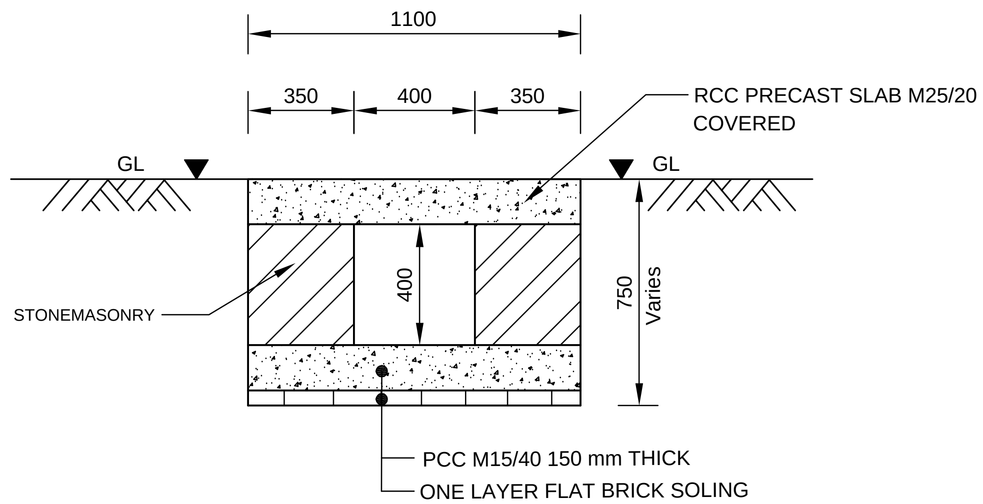


The Study on the Solid Waste Management for the Kathmandu Valley	**Figure A.2-24**
Japan International Cooperation Agency	**Drainage Layout Improvement Plan Drainage**

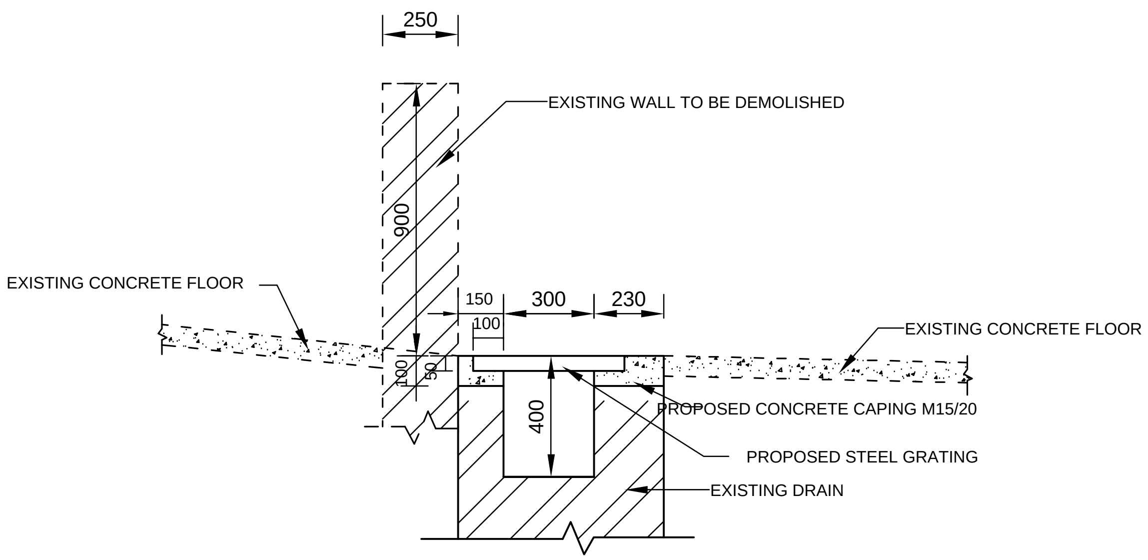
Figure A.2-24
Drainage Layout Improvement Plan
Drainage



IMPROVEMENT AT SECTION D-D
(DRAIN D5)



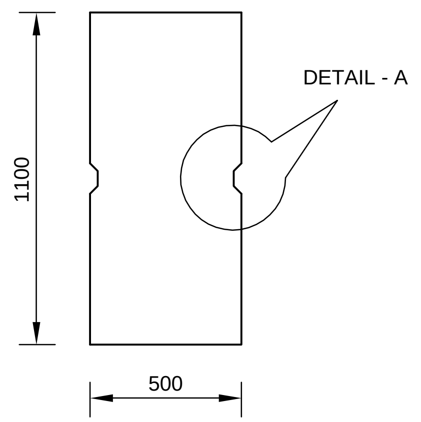
BUILT DRAIN (PD-2)



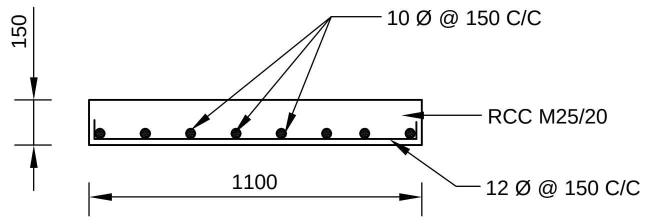
IMPROVEMENT AT SECTION I-I
(DRAIN D4)
CANCELLED

The Study on the Solid Waste Management for the Kathmandu Valley	**Figure A.2-25** **Drainage Improvement Section Detail Drainage**
Japan International Cooperation Agency	

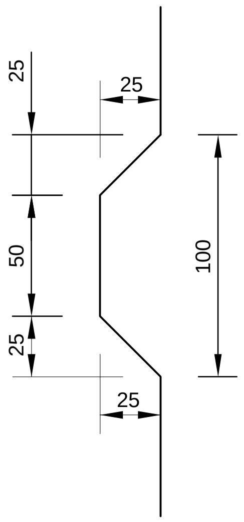
TYPICAL PRE-CAST SLAB DRAIN COVER



PLAN

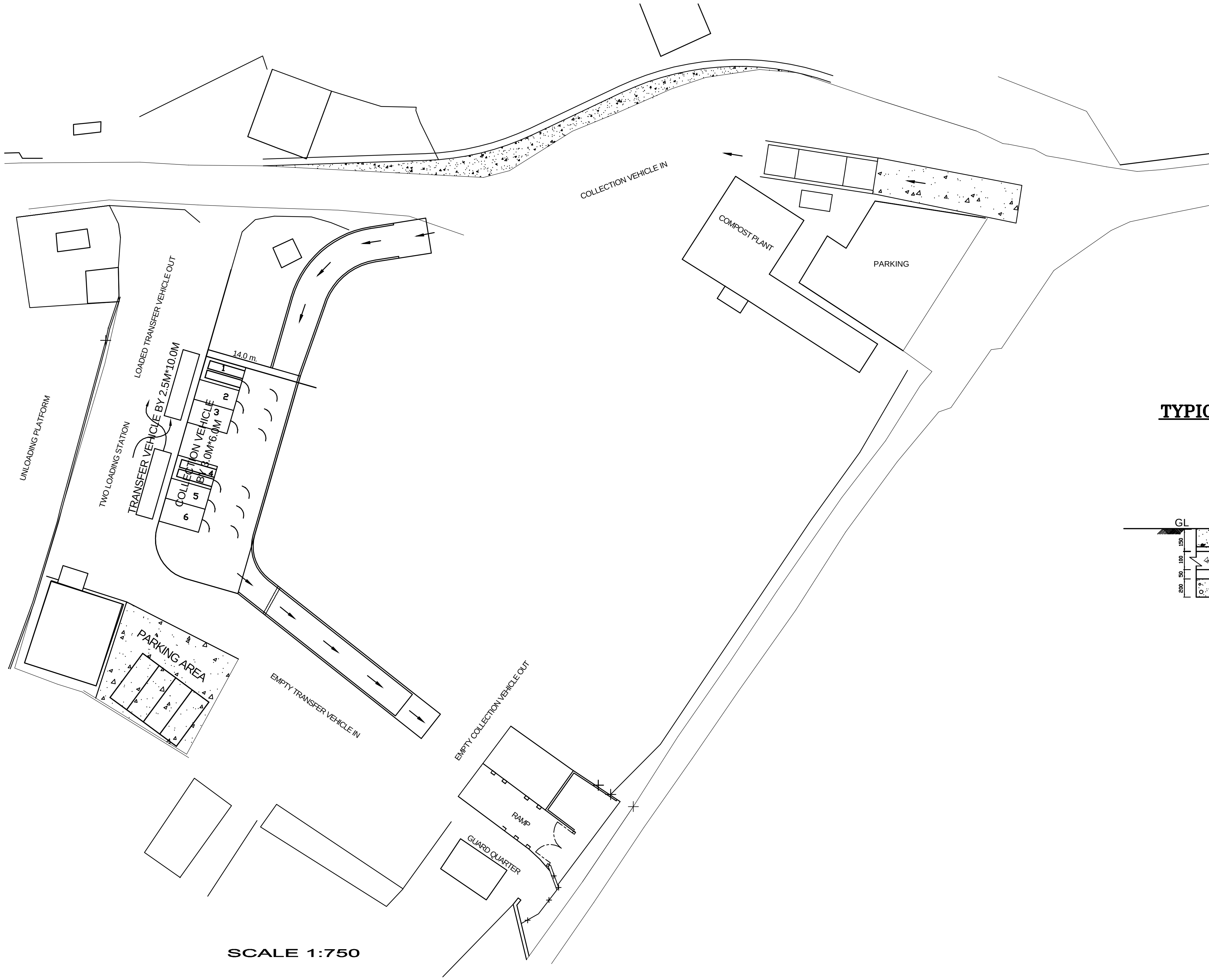


SECTION

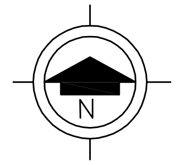


DETAIL-A

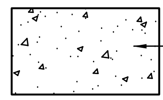
The Study on the Solid Waste Management for the Kathmandu Valley	**Figure A.2-26 Drainage Improvement Drain Cover Drainage**
Japan International Cooperation Agency	



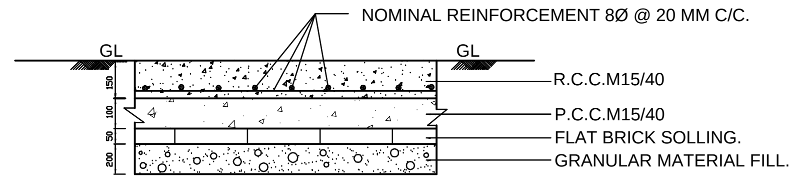
SCALE 1:750



LEGEND:



TYPICAL PAVEMENT SECTION



SCALE: - 1:20

The Study on the Solid Waste Management for the Kathmandu Valley

Japan International Cooperation Agency

Figure A.2-27
Traffic circulation and Vehicle Parking

PILOT PROJECT B

PROMOTION OF
SOLID WASTE MINIMIZATION

Pilot Project B-1

Result of Market Survey on Compost Product

Table of Contents

CHAPTER 1 SURVEY METHODOLOGY

1.1 Household Survey

A questionnaire and a set of checklist were prepared to collect the necessary information for Household Survey (HHS). A set of semi-structured questionnaire was use to collect household information with regard to agricultural landholding distribution, cropped area, productivity and production; fertilizer, manure and solid waste product compost (SW-C) use and their prices; manure production in own farm and requirement; public opinion on fertilizer, manure and SW-C, pattern; and awareness activities undertaken by concern agencies for the promotion of manure and SW-C. Five different sample areas namely Kathmandu Metropolitan City (KMC), Lalitpur Sub-metropolitan City (LSMC), Bhaktapur Municipality (BKM), Madhyapur Thimi Municipality (MTM), Kirtipur Municipality (KRM) in the Valley and two adjoining districts to the Valley: Naubise (Dhading District) and Tamaghat, Panchkhal (Kaverpalanchok District). The questionnaire was prepared both in English and Nepalese. In each site, the households (HHs) were randomly selected but little biasness given in selecting vegetable growing site. The sample sites and sample size is shown in Table 1.2-1.

Table 1.2-1 Survey Areas and Sample Size

Survey Site	District	Survey Areas	Sample Size (Nos.)
KMC	Kathmandu	Mulpani Dharmasthali	4 4
LSMC	Lalitpur	Chapangaon Thaiba	4 4
BKM	Bhaktapur	Katunge Hanumante	4 4
MTM	Bhaktapur	Bode Nagadesh	4 4
KRM	Kathmandu	Kirtipur Panga	4 4
Naubise	Dhading	Naubise	10
Tamaghat, Panchkhal	Kavre	Tamaghat	10
Total			60

1.2 Key Informant Survey

Checklists were prepared for the collection of information from relevant key informants. With help of checklists, it was aimed to collected information from officials and key farmers with regard to perception of people towards solid waste management, forwarded/launched activities from the concerned offices on solid waste management, and anticipation of farmers from the concerned offices. The team visited some hotels and nurseries to get some information about their activities and manure (manure prepared by farmers in their farmyard) or compost (commercial product produced by private agency) sale and own use in gardening. The team also visited four District Agriculture Development Offices (Kathmandu, Bhaktapur, Lalitpur and Kavre) to have perception on solid waste compost and to have related information.

1.3 Focus Group Discussions

Focus group discussion was held in few survey sites (Mulpani, Bode, Chapangaon, Thaiba, Katuge, Hanumante, Naubise, Panchkhal) and group discussions were followed on inputs use (mainly fertilizer, manure and SW-C use), cropping behaviors, cost of cultivation, and cost of inputs, availability and prices of manures, fertilizers and solid waste compost. The discussions were mainly concentrated on solid waste compost and their marketing and encountered problems if any in past.

1.4 Collection of Secondary Information

Available reports, district annual reports, reports related to solid waste management and publications of municipalities were collected to get some related information.

1.5 On Site Visit and Observations

On site observations were carried out to find the current practices related specifically to composting, manure production in their farm, requirement of manure, availability of manure and manure price and in the same way SW-C use and its availability. These visits were organized to have first hand information by the consultants by themselves.

1.6 Data Processing, Analysis and Interpretation

The questionnaire was discussed and refined in the workshop organized by JICA Study Team and it was further pre-tested in Naubise and Panchkhal for its good administration during survey. The questionnaires were collected and simple cleaning and data editing were done and conversions of units were done to bring them in standard unit form uniformity during entry and analysis. The collected information (data) has been processed and analyzed and derived tabulated form as per need of survey. The information collected in-group discussion or by key informant survey will reflected as where needed.

CHAPTER 2 SURVEY FINDINGS

2.1 Landholding Distribution

The landholding of households in survey area is estimated at 30.4 ha and operational land is 37.2 ha, which shows that farmers are renting-in land for farming specifically for vegetable growing. The average land holding size of survey area is 0.506 ha which slightly lower than Central Development Region (0.72 ha). As indicated by National Sample Census of Agriculture (2001/02), the average holding size of Kathmandu is 0.248 ha, Bhaktapur District as 0.233 ha, Lalitpur District as 0.306 ha, Kavre District as 0.685 ha and Dhading District as 0.611 ha. The land holding size of Hill Region of Central Development Region is 0.550 has. Landholding distribution and average land holding is given in Table 2.1-1.

Table 2.1-1 Landholding Distribution in the Survey Area

Municipality/District	Landholding						
	No. and % of HHs		Owner's Land		Operational Land		Average Owner's Landholding (ha)
	No. HHs	% HHs	Area (ha)	% Area	Area (ha)	% Area	
KMC Total	8.0	13.3	4.0	13.0	5.1	13.7	0.494
LSMC Total	8.0	13.3	2.7	9.0	3.0	7.9	0.341
BKM Total	8.0	13.3	2.2	7.2	4.5	12.0	0.272
MTM Total	8.0	13.3	2.0	6.5	2.3	6.2	0.248
KRM Total	8.0	13.3	2.9	9.6	8.1	21.8	0.364
Dhading Total	10.0	16.7	5.7	18.6	4.2	11.3	0.565
Kavre Total	10.0	16.7	11.0	36.1	10.1	27.0	1.095
Kathmandu Valley Total	40.0	66.7	13.8	45.3	22.9	61.7	0.344
Outside Valley Total	20.0	33.3	16.6	54.7	14.3	38.3	0.830
Overall Total	60.0	100.0	30.4	100.0	37.2	100.0	0.506

Source: Household Survey, November 2004

2.2 Area Under Major Crops

The operational area in the survey area is 37.2 ha and about 89% are found covered by summer crops. The proportion of crop coverage by paddy is high as 44.9% (early maturing paddy and normal paddy) followed by summer vegetables 31.7%, then maize (22.4%) and so on. The table shows that the Kathmandu Valley enjoys high vegetable cultivation probably vegetables being cash crop and high paying. Area covered by different summer crops is presented in the Table 2.2-1.

The total area occupied by winter crops is 27.7 ha which is 74.4% of operational land in winter season. As indicated in Table 2.2-1, area planted under vegetable is 51.6% and by potato is 26.4%. The other crop like barley, maize, oilseeds) occupy minor acreage but wheat shows 17.6% coverage.

The total area planted in spring season is 7.02 ha that is 18.9% of operational land of the planted area in spring season, different types of vegetables and hardly 2.1% area occupied by maize cover 97.8% area. Areas of different crop are given in Table 2.2-3. As indicated by Household Survey, the cropping intensity of the survey area is 182.2%.

Tale 2.2-1 Area Under Majors Crops in the Survey Area

Survey Site	Summer Crop Areas (ha)						
	Summer	Early	Normal				Summer
	Area	Paddy	Paddy	Maize	Soybean	Pulse	Vegetables
KMC Total	4.6	0.40	2.42	0.60	0.30	0.05	0.80
LSMC Total	2.9	0.00	1.03	0.55	0.00	0.00	1.28
BKM Total	3.5	0.58	1.30	0.03	0.00	0.00	1.64
MTM Total	1.8	0.06	1.76	0.03	0.00	0.00	0.00
KRM Total	6.4	0.05	0.60	0.70	0.00	0.00	5.06
Dhading Total	4.2	0.10	2.20	1.10	0.00	0.00	0.80
Kavre Total	9.7	0.00	4.35	4.40	0.00	0.00	0.90
Kathmandu Valley Total	19.2	1.08	7.11	1.90	0.30	0.05	8.77
Outside Valley Total	13.9	0.10	6.55	5.50	0.00	0.00	1.70
Overall Total	33.1	1.18	13.66	7.40	0.30	0.05	10.47

Source: Household Survey, November 2004

Tale 2.2-2 Area Under Majors Crops in the Survey Area

Survey Site	Winter Crop Areas (ha)							
	Winter Area	Wheat	Maize	Barley	Oilseeds	Potato	Vegetables	
							Cole	Bulb
KMC Total	4.87	2.55	0.13	0.00	0.00	0.60	1.56	0.03
LSMC Total	2.65	0.78	0.00	0.10	0.25	0.00	1.50	0.03
BKM Total	3.17	0.75	0.00	0.00	0.00	0.00	2.27	0.15
MTM Total	1.70	0.06	0.00	0.00	0.00	0.58	0.03	1.04
KRM Total	6.17	0.13	0.10	0.01	0.00	0.21	2.76	2.97
Dhading Total	2.80	0.35	0.40	0.00	0.15	0.00	1.90	0.00
Kavre Total	6.33	0.25	0.10	0.00	0.00	5.93	0.05	0.00
Kathmandu Valley Total	18.56	4.26	0.23	0.11	0.25	1.39	8.11	4.22
Outside Valley Total	9.13	0.60	0.50	0.00	0.15	5.93	1.95	0.00
Overall Total	27.68	4.86	0.73	0.11	0.40	7.31	10.06	4.22

Source: Household Survey, November 2004

Tale 2.2-3 Area Under Majors Crops in the Survey Area

Survey Site	Spring Crop Areas (ha)		
	Spring Area	Maize	Vegetables
KMC Total	1.10	0.00	1.10
LSMC Total	0.40	0.00	0.40
BKM Total	0.05	0.00	0.05
MTM Total	0.09	0.00	0.09
KRM Total	4.53	0.00	4.53
Dhading Total	0.15	0.15	0.00
Kavre Total	0.70	0.00	0.70
Kathmandu Valley Total	6.17	0.00	6.17
Outside Valley Total	0.85	0.15	0.70
Overall Total	7.02	0.15	6.87

Source: Household Survey, November 2004

2.3 Crop Yields

Crop yields widely vary depending on the timely irrigation, use of inputs level, good crop variety and crop management. Farmers of the Kathmandu Valley and near by districts of the Valley are highly innovated in crop farming and have ideas of catch up market demands and preference variety. The reported yields of different crops in the survey area are far higher than national average yields and regional average but close to district yields. The overall average yields of survey area of early paddy are 5.0 tons/ha, normal paddy is 4.8 tons/ha, maize as 2.9 tons/ha and vegetables produced 20.2 tons/ha. Farmers get see any marginal benefit in cereal crops except paddy. All most all farmers grow paddy to sustain their livelihood as food security otherwise farmers choose high paying crop. The yields of summer crop in survey area are illustrated below, in the Table 2.3-1.

Table 2.3-1 Yields of Summer Crops

Survey Site	Yield of Summer Crops (kg/ha)					
	Early Paddy	Normal Paddy	Maize	Soybean	Pulse	Summer Vegetables
KMC Average	4,500	5,054	3,340	740	840	15,100
LSMC Average		5,338	1,852			30,000
BKM Average	5,205	4,621	1,200			13,832
MTM Average	3,941	4,233	2,720			
KRM Average	6,000	5,467	2,429			16,055
Dhading Average	5,500	4,136	2,231			17,611
Kavre Average		5,143	3,462			21,325
Kathmandu Valley Average	4,937	4,894	2,662	740	840	20,765
Outside Valley Average	5,500	4,696	3,110			19,097
Overall Average	5,007	4,821	2,904	740	840	20,190

Source: Household Survey, November 2004

The average yield of winter crops also shows more over same pattern of yields with regional and district average yields as in summer crops. The overall average yields of winter crops of wheat, maize, potato, cole crops (winter vegetables: cauliflower, cabbage etc.), bulb crops (garlic and onions), oil crops and barley in the survey area are reported as 2.66, 2.67, 18.48, 14.40, 0.56 and 2.08 tons/ha, respectively. The reported yield shows a little higher side than district average yields and far higher yields than regional average yields. Yields of winter crops are given in the Table 2.3-1.

Spring maize and different kinds of vegetables are the main crops in spring season. The productivity of maize and spring vegetables is reported as 2.26 and 19.38 tons/ha. Farmers in the valley use their lands for vegetable production rather the cereal crop production.

Table 2.3-2 Yields of Winter Crops

Survey Site	Yields of Winter Crops (Kg/ha)						
	Wheat	Maize	Barley	Oilseeds	Potato	Vegetables	
						Cole	Bulb
KMC Average	2,356	2,100			13,640	26,732	8,000
LSMC Average	3,096		2,720	533		27,296	8,000
BKM Average	3,170					15,854	12,200
MTM Average	1,880				14,250	20,000	16,288
KRM Average	2,380	3,000	1,440		20,667	21,934	16,486
Dhading Average	3,022	2,560		620		20,278	
Kavre Average	1,800	3,400			21,938		
Kathmandu Valley Average	2,651	2,550	2,080	533	15,600	23,078	14,403
Outside Valley Average	2,717	2,840		620	21,938	20,278	
Overall Average	2,663	2,674	2,080	562	18,481	22,358	14,403

Source: Household Survey, November 2004

Table 2.3-3 Yields of Spring Crops

Survey Site	Spring Crops (kg/ha)	
	Maize	Vegetables
KMC Average		12,190
LSMC Average		23,333
BKM Average		10,000
MTM Average		12,190
KRM Average		24,538
Dhading Average	2,267	
Kavre Average		22,967
Kathmandu Valley Average		23,139
Outside Valley Average	2,267	22,967
Overall Average	2,267	19,377

Source: Household Survey, November 2004

2.4 Fertilizer, Manure and Solid Waste Compost Use in the Survey Area

Farmers of the survey areas are using higher amount of fertilizers and manures, in the same way they are harvesting good crop production specially vegetables. Inputs use rate by the farmers in the survey areas and percent of households using inputs well illustrated. Information shown below indicates the overall average of the survey area;

2.4.1 Use Rate of Inputs (Fertilizer, Manure and SW-C) in Survey Areas

Overall average use rate of fertilizer, manure and compost in different crops in the survey area is presented below in Table 2.4.1. Farmers are applying comparatively higher level of inputs in cereal crops and very high rates in vegetable farming. Use of farm manures depends on quantity available in the farm households and acreage to be cultivated. If a farmer has little land and produces huge amount of manure, obviously farmers will be using higher amount of manure but they will not buy manure for cereal crops. A farmers growing vegetable, will be buying manure for farming because they are sure of return from vegetables.

Table 2.4-1 Inputs Use in Different Crops in Survey Area

(Unit: kg/ha)

Inputs	Summer Crops						Winter Crops							Spring Crops	
	Early Paddy	Normal Paddy	Maize	Soy bean	Pulse	Summer Vegetables	Wheat	Maize	Barley	Oilseeds	Potato	Vegetables: Cole	Vegetables: Bulb	Maize	Vegetables
Urea	163	190	121	0	20	335	170	154	75	113	241	388	340		140.9
DAP	127	96	28	0	0	203	79	57	0	0	501	214	423		109.3
Potash	22	11	0	0	0	44	16	0	0	17	142	56	47	0	
Manure	2,211	3,824	10,064	0	9,000	12,047	3,651	1,571	10,000	4,000	12,051	14,438	12,728	1600	7,958
SWP-Compost	0	63	81	0	0	690	0	0	0	0	1,491	1,903	1,193	0	

Source: Household Survey, November 2004

2.4.2 Households Using Inputs (Fertilizer, Manure and SW-C)

a) Households Using Inputs in Overall Basis

The result of household survey regarding households using inputs in different crops is given in Tables 2.4-2 to 2.4-5. Table 2.4-2 shows an average percent of households using fertilizer (irrespective of type of fertilizers), Table 2.4-3 shows percent households using manure, Table 2.4-4 shows percent households using SW-C and Table 2.4-5 shows overall average percent of households using different types of inputs as fertilizers, manure and SW-compost. The figures of Table 2.4-5 are as of overall basis not users' basis.

As indicated by survey result, 95% households reported using chemical fertilizer in crop production (irrespective of type of fertilizers). The overall average of survey area has indicated that 87% households are using fertilizer in paddy and 90% households reported using fertilizer in vegetables and half of the households expressed using fertilizers in each crop as wheat, maize and potato.

Table 2.4-3 shows that almost all farm households are using manure for crop production. As reported by farm households, 93% households use manure in vegetables, 62% households reported using in paddy, 52% in maize and 55% households in potato and so on. Farmers are well aware of using manure in their field for both nutrients supplement as well as to enrich the soil with organic matter.

Farmers are not so aware of SW-C. As an overall average, about 37% of households have heard about SW-C but only 20% households responded that they are using SW-C (Table 2.4-4). The quantities used by households are of very little quantity. The survey team estimates that the figure should go further down because farmers might be confused that the entire market compost product called as compost are of SW-C. None of the Municipality is producing SW-C except BKM but there are numerous private agencies that are producing compost. Bhaktapur composting facility is producing SW-C in very little quantity, which is under demand.

Table 2.4-2 Household Using Fertilizer in the Survey Area

Survey Area	% HHs Using Fertilizer	% Households Using Chemical Fertilizer in Different Crops						
		Paddy	Wheat	Maize	Lentil	Oilseeds	Potato	Vegetables
KMC Average	100.0	87.5	87.5	87.5	0.0	0.0	50.0	75.0
LSMC Average	100.0	75.0	50.0	37.5	0.0	12.5	0.0	100.0
BKM Average	100.0	100.0	75.0	12.5	0.0	0.0	62.5	87.5
MTM Average	100.0	87.5	12.5	25.0	0.0	0.0	50.0	100.0

Survey Area	% HHs Using Fertilizer	% Households Using Chemical Fertilizer in Different Crops						
		Paddy	Wheat	Maize	Lentil	Oilseeds	Potato	Vegetables
KRM Average	87.5	62.5	37.5	25.0	0.0	0.0	25.0	87.5
Dhading Average	80.0	90.0	70.0	90.0	20.0	40.0	70.0	80.0
Kavre Average	100.0	100.0	20.0	90.0	0.0	10.0	90.0	100.0
Kathmandu Valley Average	97.5	82.5	52.5	37.5	0.0	2.5	37.5	90.0
Outside Valley Average	90.0	95.0	45.0	90.0	10.0	25.0	80.0	90.0
Overall Average	95.0	86.7	50.0	55.0	3.3	10.0	51.7	90.0

Note: HHs = Households
Source: Household Survey, November 2004

Table 2.4-3 Household Using Manure in the Survey Area

Survey Site	% HHs Using Compost	% HHs Using Manure in Different Crops						
		Paddy	Wheat	Maize	Lentil	Oilseeds	Potato	Vegetables
KMC Average	87.5	87.5	87.5	87.5	0.0	0.0	62.5	75.0
LSMC Average	100.0	62.5	37.5	37.5	0.0	12.5	0.0	100.0
BKM Average	100.0	75.0	50.0	12.5	0.0	0.0	62.5	87.5
MTM Average	100.0	37.5	12.5	0.0	0.0	0.0	50.0	100.0
KRM Average	100.0	12.5	12.5	12.5	0.0	0.0	37.5	100.0
Dhading Average	90.0	80.0	70.0	90.0	30.0	60.0	70.0	90.0
Kavre Average	100.0	70.0	0.0	100.0	0.0	0.0	90.0	100.0
Kathmandu Valley Average	97.5	55.0	40.0	30.0	0.0	2.5	42.5	92.5
Outside Valley Average	95.0	75.0	35.0	95.0	15.0	30.0	80.0	95.0
Overall Average	96.7	61.7	38.3	51.7	5.0	11.7	55.0	93.3

Source: Household Survey, November 2004

Table 2.4-4 Household Using SW-C in the Survey Area

Survey Site	% HHs have Idea of SW-C	% HHs Using SW-C	% HHs Using SW-Compost in Different Crops						
			Paddy	Wheat	Maize	Lentil	Oilseeds	Potato	Vegetables
KMC Average	50.0	50.0	37.5	0.0	25.0	0.0	0.0	25.0	37.5
LSMC Average	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BKM Average	100.0	50.0	0.0	0.0	0.0	0.0	0.0	12.5	50.0
MTM Average	62.5	37.5	0.0	0.0	0.0	0.0	0.0	25.0	25.0
KRM Average	25.0	12.5	0.0	0.0	0.0	0.0	0.0	12.5	25.0
Dhading Average	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kavre Average	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kathmandu Valley Average	47.5	30.0	7.5	0.0	5.0	0.0	0.0	15.0	27.5
Outside Valley Average	15.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Overall Average	36.7	20.0	5.0	0.0	3.3	0.0	0.0	10.0	18.3

Source: Household Survey, November 2004

Percent of households using different types of fertilizer, manure and compost in different crops is presented below (Table 2.4-5). Higher numbers of farmers are using fertilizer and manure in vegetables, potato and paddy.

Table 2.4-5 Household Using Inputs in Survey Area

(Unit: %HHs)

Inputs	Summer Crops						Winter Crops							Spring Crops	
	Early Paddy	Normal Paddy	Maize	Soy bean	Pulse	Summer Vegetables	Wheat	Maize	Barley	Oilseeds	Potato	Vegetables: Cole	Vegetables: Bulb	Maize	Vegetables
Urea	10.0	80.0	41.7	0.0	1.7	43.3	33.3	6.7	1.7	5.0	36.7	55.0	20.0	1.7	20.0
DAP	11.7	55.0	10.0	0.0	0.0	45.0	16.7	5.0	0.0	0.0	30.0	55.0	18.3	0.0	25.0
Potash	6.7	20.0	1.7	0.0	0.0	33.3	8.3	0.0	0.0	0.0	23.3	45.0	8.3	0.0	11.7
Manure	6.7	30.0	36.7	0.0	1.7	41.7	20.0	3.3	1.7	3.3	35.0	51.7	21.7	1.7	23.3
SWP-Compost	0.0	5.0	3.3	0.0	0.0	1.7	0.0	0.0	0.0	0.0	8.3	3.3	10.0	0.0	3.3

Source: Household Survey, November 2004

b) Households Using Inputs in Overall Crop Grower Basis

The percent of households using inputs in overall users' basis is summarized in Table 2.4-6. The table shows the percent of households in terms of users' basis. The user basis reflects, percent of households using inputs out of grower of specific crops. Greater number of households are using urea, DAP and manure but few households are using potash and negligible farm households are using SW-C.

Table 2.4-5 Households Using Inputs in Different Crops

Survey Site	% HHs Using Inputs in Summer Crops				% HHs Using Inputs in Winter Crops					% HHs Using Inputs in Spring Crops	
	Early Paddy	Normal Paddy	Maize	Vegetables	Wheat	Maize	Potato	Vegetables: Cole	Vegetables: Bulb	Maize	Vegetables
Urea	75.0	98.0	96.2	89.7	90.9	57.1	100.0	91.7	70.6	100.0	66.7
DAP	87.5	67.3	23.1	93.1	45.5	42.9	81.8	91.7	64.7	0.0	83.3
Potash	50.0	24.5	3.8	69.0	22.7	0.0	63.6	75.0	29.4	0.0	38.9
Manure	50.0	36.7	84.6	86.2	54.5	28.6	95.5	86.1	76.5	100.0	77.8
SW-Compost	0.0	6.1	7.7	3.4	0.0	0.0	22.7	5.6	35.3	0.0	11.1

Source: Household Survey, November 2004

2.4.3 Inputs Use since Last Five Consecutive Years in the Survey Areas

Fertilizer Use

The fertilizer consumption for last five consecutive years is summarized in the Table 2.4-6. The table indicates that fertilizer use pattern is increasing that shows that farmers are good aware of fertilizer use and about its importance. This table reflects the tendency of farmers about using the chemical fertilizers.

Table 2.4-6 Fertilizer Use in Last Consecutive Years in the Survey Area

(Unit: Tons)

Survey Site	FY1999/00			FY2000/01			FY2001/02			FY2002/03			FY2003/04		
	Urea	DAP	Pot.	Urea	DAP	Pot.	Urea	DAP	Pot.	Urea	DAP	Pot.	Urea	DAP	Pot.
KMC Total	0.9	1.0	0.4	0.9	1.0	0.4	1.0	1.1	0.4	1.0	1.1	0.5	1.0	1.2	0.5
LSMC Total	0.9	0.4	0.1	0.9	0.4	0.1	0.9	0.5	0.1	1.2	0.6	0.2	1.0	0.7	0.2
BKM Total	1.8	0.3	0.3	2.1	1.0	0.4	2.3	1.1	0.4	3.0	1.1	0.5	4.2	1.1	0.5
MTM Total	0.9	1.6	0.0	0.9	1.6	0.0	1.0	1.6	0.0	1.2	1.5	0.0	1.6	1.6	0.0
KRM Total	0.2	0.1	0.0	0.2	0.1	0.0	0.3	0.2	0.0	0.6	0.3	0.1	2.4	1.6	0.5
Dhading Total	1.1	0.7	0.0	1.6	1.1	0.0	1.7	1.3	0.0	1.8	1.3	0.1	1.9	1.3	0.1
Kavre Aver./Total	3.7	5.1	0.4	1.7	5.2	0.5	1.7	5.3	0.7	1.8	5.5	0.8	2.1	5.9	1.1
Valley Total	4.7	3.3	0.8	5.1	4.0	0.9	5.5	4.5	1.0	7.0	4.7	1.2	10.1	6.2	1.6
Outside Valley Total	4.8	5.7	0.5	3.3	6.4	0.5	3.5	6.6	0.8	3.6	6.8	0.9	4.0	7.2	1.2
Overall Total	9.4	9.1	1.3	8.4	10.4	1.4	9.0	11.1	1.8	10.6	11.4	2.2	14.1	13.4	2.9

Source: Household Survey, November 2004

Manure Use

The manure consumption for last five consecutive years is presented in the Table 2.4-7. This table reflects the tendency of farmers about using the manure. Farmers are purchasing more than 25% of their requirement of manure from others and bring from adjoining districts sometimes from Narayanghat. About 47% of households have reported that they are buying manure for crop production due to insufficiency of the manure produced in own farm (Table 2.4-8) in the last year. The table indicates that manure use pattern increasing, which shows that farmers are traditionally aware of using manure and they value its use as sustainability of soil fertility.

Table 2.4-7 Manure Use in Last Five Consecutive Years in the Survey Area

(Unit: Tons)

Survey Site	FY1999/00			FY2000/01			FY2001/02			FY2002/03			FY2003/04		
	Own	Purch.	Total	Own	Purch.	Total	Own	Purch.	Total	Own	Purch.	Total	Own	Purch.	Total
KMC Total	65.4	2.5	67.9	70.6	2.0	72.6	66.7	2.3	69.0	66.1	3.3	69.4	66.1	3.4	69.5
LSMC Total	42.6	23.8	66.4	40.7	16.6	57.3	41.7	23.8	65.5	42.7	27.8	70.5	41.0	30.2	71.2
BKM Total	1.2	5.0	6.2	1.5	18.1	19.6	2.0	17.5	19.5	3.0	24.5	27.5	3.1	35.3	38.4
MTM Total	13.1	22.7	35.8	14.7	27.6	42.3	39.5	28.2	67.7	14.4	29.8	44.1	15.6	30.7	46.3
KRM Total	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	3.8	13.5	0.0	13.5	42.0	20.4	62.4
Dhading Total	61.5	0.0	61.5	68.9	0.4	69.3	72.7	2.2	74.9	69.1	3.4	72.5	61.7	5.0	66.7
Kavre Aver./Total	132.6	4.6	137.2	144.8	4.6	149.4	150.5	4.6	155.1	171.4	4.6	176.0	174.2	16.0	190.2
Valley Total	122.3	54.0	176.3	127.5	64.3	191.7	153.7	71.7	225.4	139.7	85.3	225.0	167.8	119.9	287.8
Outside Valley Total	194.1	4.6	198.7	213.7	5.0	218.7	223.2	6.8	230.0	240.5	8.0	248.5	235.9	21.0	256.9
Overall Total	316.4	58.6	375.0	341.2	69.3	410.4	376.9	78.5	455.3	380.1	93.3	473.4	403.7	140.9	544.6
% Purchased Quantity	84.4	15.6	100.0	83.1	16.9	100.0	82.8	17.2	100.0	80.3	19.7	100.0	74.1	25.9	100.0

Note: Purch = Purchased
Source: Household Survey, November 2004

Table 2.4-8 Households Purchasing Manure in Last Five Consecutive Years in the Survey Area

(Unit: Tons)

Survey Site	FY1999/00		FY2000/01		FY2001/02		FY2002/03		FY2003/04	
	Own	Purchased	Own	Purchased.	Own	Purchased.	Own	Purchased.	Own	Purchased.
KMC Ave./Total	100.0	12.5	100.0	12.5	100.0	12.5	100.0	25.0	100.0	25.0
LSMC Aver./Total	87.5	50.0	87.5	50.0	87.5	50.0	87.5	62.5	75.0	75.0
BKM Aver./Total	50.0	50.0	50.0	62.5	25.0	62.5	37.5	62.5	50.0	62.5
MTM Aver./Total	100.0	62.5	100.0	62.5	62.5	62.5	62.5	62.5	75.0	75.0
KRM Aver./Total	0.0	0.0	0.0	0.0	37.5	0.0	50.0	0.0	87.5	37.5
Dhading Aver./Total	100.0	0.0	100.0	10.0	90.0	30.0	90.0	30.0	90.0	30.0
Kavre Aver./Total	100.0	10.0	100.0	10.0	100.0	10.0	100.0	10.0	100.0	30.0
Valley Aver./Total	67.5	35.0	67.5	37.5	62.5	37.5	67.5	42.5	77.5	55.0
Outside Valley Aver. Total	100.0	5.0	100.0	10.0	95.0	20.0	95.0	20.0	95.0	30.0
Overall Aver./Total	78.3	25.0	78.3	28.3	73.3	31.7	76.7	35.0	83.3	46.7

Source: Household Survey, November 2004

The manure consumption for last five consecutive years is given in the Table 2.4-9. The table indicates that the SW-C use pattern increasing except last fiscal year but amount used by households is very limited. This table reflects that the tendency of farmers about using the SW-C found not encouraging but team observes it is influenced by availability of products in the market.

Table 2.4-9 SW-C Use in Last Five Consecutive Years in the Survey Area

(Unit: Tons)

Survey Sites	FY1999/00	FY2000/01	FY2001/02	FY2002/03	FY2003/04
Kathmandu Total	**0.6**	**0.0**	**0.4**	**0.6**	**0.6**
KRM Total	1.5	1.5	1.5	1.5	0.0
LSMC Total	0.0	0.0	0.0	0.0	0.0
BKM Total	4.2	4.2	4.2	4.4	4.6
MTM Total	0.2	0.4	0.5	3.5	4.0
Dhading Total	0.0	0.0	0.0	0.0	0.0
Kavre Aver./Total	0.0	0.0	0.0	0.0	0.0
Valley Total	6.0	6.2	6.6	10.0	9.2
Outside Valley Total	0.0	0.0	0.0	0.0	0.0
Overall Total	6.5	6.2	6.6	10.0	9.2

Source: Household Survey, November 2004

2.4.4 Households Responding to Inputs Availability

The responses of the farmers regarding the availability of fertilizer, fertilizer buying place and quality of fertilizer is presented in the Table 2.4-10. Most of the farmers reported (90%) that there are no problems of buying fertilizers, they are being available in the residing area or near by area. Farmers have less confidence (8%) and doubt on products sold by private agencies but have faith (67%) on the products sold by Fertilizer Company.

Table 2.4-10 Percent Households Responding to Fertilizer Availability in the Survey Area

(Unit: %)

Survey Area	% HHs Resp. to Avai.of Fertilizer	% HHs buying Fertilizer			Agriculture Input Company		Private Dealers	
		Village Market	VDC Market	District Market	Good	Poor	Good	Poor
KMC Average	75.0	75.0	0.0	25.0	87.5	0.0	0.0	87.5
LSMC Average	100.0	100.0	0.0	0.0	75.0	0.0	37.5	62.5
BKM Average	100.0	75.0	25.0	0.0	75.0	25.0	0.0	37.5
MTM Average	87.5	75.0	12.5	0.0	50.0	25.0	12.5	25.0
KRM Average	87.5	62.5	0.0	25.0	37.5	37.5	0.0	50.0
Dhading Average	90.0	90.0	10.0	10.0	70.0	20.0	10.0	80.0
Kavre Average	90.0	90.0	0.0	10.0	70.0	30.0	0.0	80.0
Valley Average	90.0	77.5	5.0	10.0	65.0	17.5	10.0	52.5
Outside Valley Average	90.0	90.0	5.0	10.0	70.0	25.0	5.0	80.0
Overall Average	90.0	81.7	5.0	10.0	66.7	20.0	8.3	61.7

Source: Household Survey, November 2004
Note: Village market = own village or residing ward, VDC market = in residing VDC but other wards and District Market = District Headquarter

The responses of the farmers regarding the availability of manure, manure buying place and quality of manure is presented in the Table 2.4-11. Most of the farmers reported (70%) that there are no problems of getting manure, they are being available in the residing area or near by area but sometimes it is not sure of getting it. Farmers are satisfied with the village product or manure.

Table 2.4-11 Percent Households Responding to Manure Availability in the Survey Area

Survey Site	% HHs Resp. Manure Availability	% HHs Getting Manure				% HHs Responding Manure Quality			
		Own Product	Village Market	VDC Market	NA	Good	Bad	Ave.	NA
KMC Average	50.0	37.5	12.5	0.0	50.0	25.0	12.5	25.0	37.5
LSMC Average	50.0	50.0	12.5	37.5	0.0	12.5	0.0	75.0	12.5
BKM Average	87.5	50.0	25.0	25.0	0.0	100.0	0.0	0.0	0.0
MTM Average	100.0	0.0	50.0	50.0	0.0	50.0	0.0	37.5	12.5
KRM Average	62.5	25.0	0.0	37.5	0.0	87.5	0.0	12.5	0.0
Dhading Average	40.0	10.0	20.0	20.0	50.0	80.0	0.0	10.0	10.0
Kavre Average	100.0	0.0	10.0	90.0	0.0	70.0	0.0	30.0	0.0
Valley Average	70.0	32.5	20.0	37.5	10.0	55.0	2.5	30.0	12.5
Outside Valley Average	70.0	5.0	15.0	55.0	25.0	75.0	0.0	20.0	5.0
Overall Average	70.0	23.3	18.3	43.3	15.0	61.7	1.7	26.7	10.0

Source: Household Survey, November 2004
Note: NA = No answer

The responses of the farmers regarding the availability SW-C, SW-C buying place and quality of SW-C are presented in the Table 2.4-12. Very few households reported (3%) about the availability of SW-C but 97% of the households reported that the farmers are unaware of SW-C products, their availability and product quality. 20% of households found using SW-C and 12% households have reported the quality of compost was good and 8% households were not satisfied with the products.

Table 2.4-12 Percent Households Responding Availability and Source of SW-C in the Survey Area

Survey Site	% HHs Response to Availability of SW-C	% HHs Using SW-C	% HHs Buying SW-C					% HHs Responding on SW-C Quality			
			Village Market	VDC Market	District Market	Factory Site	No Answer	Good	Bad	Ave.	No Resp.
KMC Average	0.0	50.0	0.0	0.0	0.0	50.0	50.0	12.5	0.0	37.5	50.0
LSMC Average	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
BKM Average	0.0	50.0	0.0	0.0	12.5	37.5	50.0	37.5	37.5	12.5	12.5
MTM Average	12.5	37.5	0.0	0.0	0.0	37.5	62.5	25.0	0.0	25.0	50.0
KRM Average	12.5	12.5	12.5	0.0	0.0	0.0	87.5	12.5	12.5	0.0	87.5
Dhading Average	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	20.0	80.0
Kavre Average	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	20.0	80.0
Valley Average	5.0	30	2.5	0.0	2.5	25.0	70.0	17.5	10.0	15.0	60.0
Outside Valley Average	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	20.0	80.0
Overall Average	3.3	20	1.7	0.0	1.7	16.7	80.0	11.7	6.7	16.7	66.7

Source: Household Survey, November 2004

2.4.5 Future Requirement of Manure

The present manure use quantity and future requirement of manure as expressed and estimated by farmers is given in Table 2.4-13. Present use rate of manure is about 6.3 tons (crop area - 67.8 ha) and proposed manure quantity needed is 11.1 tons, which is 78.1% higher than present use. This interest of farmers in further increased use of will support to increase the production of manure or supplemented SW-C, if SW-C available in the market. As indicated in the table, 80% of the households prepare manure in their farm, 87% households use manure. 35% households of reported that their production is sufficient for their use and cent percent households reported their future quantum needed and 78% households reported that manure use practice is increasing.

Table 2.4-13 Present Use of Manure and Anticipated Manure Requirement of the Households

Survey Site	% HHs Preparing Manure in Own Farm		%HHs Reporting Sufficiency of Manure		HHs Reporting Present Manure Use		HHs Reporting Future Manure Use		% HHs Responding to Manure Requirement Pattern			
	Yes	No	Yes	No	% HHs	Quantity (Tons)	% HHs	Quantity (Tons)	Incr.	Decr.	Same	No Resp.
KMC Ave./Total	100.0	0.0	25.0	75.0	100.0	64.5	100.0	173.6	50.0	12.5	25.0	12.5
LSMC Aver./Total	87.5	12.5	25.0	75.0	87.5	37.9	100.0	65.4	62.5	25.0	12.5	0.0
BKM Aver./Total	50.0	50.0	37.5	62.5	50.0	3.3	100.0	41.8	87.5	0.0	12.5	0.0
MTM Aver./Total	50.0	50.0	12.5	87.5	62.5	15.3	100.0	40.8	87.5	0.0	12.5	0.0
KRM Aver./Total	75.0	25.0	37.5	62.5	100.0	51.0	100.0	101.5	87.5	0.0	12.5	0.0
Dhading Aver./Total	90.0	10.0	30.0	70.0	100.0	71.9	100.0	103.7	90.0	0.0	10.0	0.0
Kavre Aver./Total	100.0	0.0	70.0	30.0	100.0	179.3	100.0	227.3	80.0	0.0	20.0	0.0
Valley Aver./Total	72.5	27.5	27.5	72.5	80.0	172.0	100.0	423.0	75.0	7.5	15.0	2.5
Outside Valley Aver. Total	95.0	5.0	50.0	50.0	100.0	251.2	100.0	331.0	85.0	0.0	15.0	0.0
Overall Aver./Total	80.0	20.0	35.0	65.0	86.7	423.2	100.0	753.9	78.3	5.0	15.0	1.7

Source: Household Survey, November 2004

2.5 Livestock Farming and Manure Production

2.5.1 Livestock Farming and Manure Production

Livestock and farming is closely integrated and supplementing to each other. Farmers of survey area are rearing livestock for the animal products and as well as production of manure to supplement nutrients to the crops. Farm animals are the main source of manure for composting and make large quantity of manure mixing with plant residues and plant debris. As reported by farm households 442 tons of manure are produced in the survey area, which counts average production of 7.3 Tons of manure per household. Total livestock numbers and manure production in the survey area is given in the Table 2.5-1.

Table 2.5-1 Livestock Farming and Manure Production in the Survey Area

Survey Site	Total Numbers of Livestock Rearing (Nos.)				Total Production of Manure in Farm (Tons)				
	Cattle	Buffalo	Goat	Others	Cattle	Buffalo	Goat	Others	Total
KMC Total	19	0	17	1800	28.8	0.0	7.2	66.0	101.9
LSMC Total	9	1	20	0	27.2	8.0	7.2	0.0	42.4
BKM Total	1	1	2	0	0.5	1.2	1.5	0.0	3.2
MTM Total	0	0	1	800	0.0	0.0	0.1	1.7	1.8
KRM Total	6	0	24	635	22.4	0.0	3.7	28.7	54.8
Dhading Total	15	2	23	2	42.5	15.0	4.3	0.5	62.2
Kavre Aver./Total	10	22	56	6036	35.0	99.3	35.0	6.3	175.6
Valley Total	35	2	64	3235	78.9	9.2	19.7	96.4	204.2
Outside Valley Total	25	24	79	6038	77.5	114.3	39.3	6.8	237.8
Overall Total	60	26	143	9273	156.3	123.5	59.0	103.2	442.0

Source: Household Survey, November 2004

2.5.2 Tendency of Farmers on Livestock Farming and Manure Production

Percent of households responding to tendency of livestock farming and manure production in the survey area is presented in the Table 2.5-2**.** The table shows that hardly 13% of households reported saying livestock farming is increasing otherwise rest of the households responded as decreasing or remained same or some did not responded anything.

Table 2.5-2 Households Responding to Livestock Rearing and Manure Production

Survey Site	% HHs Responding Livestock Farming				% HHs Responding Manure Production Pattern			
	Incr.	Decr.	Same	NR	Incr.	Decr.	Same	NR
KMC Average	12.5	50.0	25.0	12.5	0.0	37.5	25.0	37.5
LSMC Average	0.0	0.0	87.5	12.5	0.0	0.0	87.5	12.5
BKM Average	0.0	12.5	25.0	62.5	0.0	12.5	25.0	62.5
MTM Average	0.0	12.5	0.0	87.5	0.0	0.0	12.5	87.5
KRM Average	50.0	0.0	12.5	37.5	50.0	0.0	12.5	37.5
Dhading Average	0.0	30.0	60.0	10.0	0.0	60.0	30.0	10.0
Kavre Average	30.0	20.0	50.0	0.0	20.0	10.0	40.0	30.0
Valley Average	12.5	15.0	30.0	42.5	10.0	10.0	32.5	47.5
Outside Valley Average	15.0	25.0	55.0	5.0	10.0	35.0	35.0	20.0
Overall Average	13.3	18.3	38.3	30.0	10.0	18.3	33.3	38.3

Note: NR=No Response

2.6 Solid Waste Product Compost

2.6.1 Response of Households on SW-C Use

Farmers' interest, households using SWP-C and reasons for not using SW-C are presented in the Table 2.6-1. As an overall average, 20% of households found using SW-C but it is of little quantity. The survey team estimates that the figure should go further down because they might be confused that the entire market product called as compost are of SW-C. None of the Municipality is producing SW-C except Bhaktapur Municipality but there are numerous private agencies that are producing compost

The main reasons for not using SW-C is unaware about compost and unavailability of products but 90% of households reported that they are interested to use SW-compost.

Table 2.6-1 Farmers' Response to SW-C

Survey Site	% HHs Using SW-C	% HHs Responding Reasons for not Using SW-C						% HHs Responding their Interest on SW-C		
		Not Avail	Too Far	Too Exp.	Not Needed	Not Known	NR	Yes	No	NR
KMC Average	50.0	12.5	0.0	0.0	0.0	37.5	62.5	100.0	0.0	0.0
LSMC Average	0.0	50.0	0.0	0.0	0.0	50.0	0.0	100.0	0.0	0.0
BKM Average	50.0	25.0	0.0	0.0	25.0	12.5	37.5	100.0	0.0	0.0
MTM Average	37.5	0.0	0.0	0.0	0.0	37.5	62.5	100.0	0.0	0.0
KRM Average	12.5	50.0	0.0	25.0	0.0	37.5	12.5	100.0	0.0	0.0
Dhading Average	0.0	30.0	0.0	0.0	0.0	20.0	50.0	90.0	0.0	10.0
Kavre Average	0.0	0.0	0.0	0.0	10.0	90.0	0.0	50.0	50.0	0.0
Valley Average	30.0	27.5	0.0	5.0	5.0	35.0	35.0	100.0	0.0	0.0
Outside Valley Average	0.0	15.0	0.0	0.0	5.0	55.0	25.0	70.0	25.0	5.0
Overall Average	20.0	23.3	0.0	3.3	5.0	41.7	31.7	90.0	8.3	1.7

Source: Household Survey, November 2004

2.6.2 Affect of SW-C in Agriculture Production

There is no flow of SW-C in the market but 20% of the households expect that the use of SW-C will increase in future, if it could be made available. About 73% of the households expressed their faith that the SW-C will improve soil fertility and consequently the crop production. Further, 97% of the farmers have expressed that solid waste management will improve sanitation and 93% households have it will also help to improve soil fertility (Table 2.6-2). Solid waste management will help to improve public sanitation and good compost source for soil enrichment.

Table 2.6-2 Affect of SW-C in Agriculture Production

Survey Site	% HHs Reporting of SW-C Use Pattern			% HHs Reporting Affect of SWP-C on Production			% HHs Reporting Importance of SWP-C					% HHs Reporting SWM Improves Sanitation			% HHs Reporting SW-C Improve Soil Fertility		
	Incr.	Decr.	NR	Incr.	Decr.	NR	1	2	3	4	5	Yes	No	NR	Yes	No	NR
KMC Average	25.0	12.5	62.5	62.5	0.0	37.5	87.5	75.0	50.0	12.5	0.0	100.0	0.0	0.0	100.0	0.0	0.0
LSMC Average	0.0	0.0	100.0	87.5	0.0	12.5	12.5	37.5	100.0	25.0	87.5	100.0	0.0	0.0	100.0	0.0	0.0
BKM Average	50.0	25.0	25.0	87.5	0.0	12.5	75.0	12.5	75.0	25.0	75.0	100.0	0.0	0.0	100.0	0.0	0.0
MTM Average	50.0	0.0	50.0	75.0	0.0	25.0	12.5	50.0	37.5	0.0	75.0	100.0	0.0	0.0	100.0	0.0	0.0
KRM Average	25.0	0.0	75.0	62.5	0.0	37.5	75.0	50.0	62.5	37.5	12.5	100.0	0.0	0.0	87.5	0.0	12.5
Dhading Average	0.0	10.0	90.0	80.0	0.0	20.0	50.0	10.0	50.0	0.0	80.0	90.0	0.0	10.0	80.0	10.0	10.0
Kavre Average	0.0	0.0	100.0	20.0	0.0	80.0	20.0	0.0	60.0	10.0	20.0	90.0	10.0	0.0	90.0	10.0	0.0
Valley Average	30.0	7.5	62.5	75.0	0.0	25.0	52.5	45.0	65.0	20.0	50.0	100.0	0.0	0.0	97.5	0.0	2.5
Outside Valley Average	0.0	5.0	95.0	50.0	0.0	50.0	35.0	5.0	55.0	5.0	50.0	90.0	5.0	5.0	85.0	10.0	5.0
Overall Average	20.0	6.7	73.3	66.7	0.0	33.3	46.7	31.7	61.7	15.0	50.0	96.7	1.7	1.7	93.3	3.3	3.3

Source: Household Survey, November 2004
Note: 1. Sanitation, 2. Nutrient available, 3. Increase production, 4. Cheaper than fertilizer and 5. Improves soil fertility.

2.6.3 Manure and SW-C Promotion Awareness Program

Public awareness is must for business promotion. Unless, one notify about the products no one will come to buy. About 33% households expressed that they have notices activities initiated for the promotion of manure preparation and only 12% households have said they have got some information about SW-C. As indicated in the table, 27% households have attended compost preparation training and hardly 8% of the households have attended agricultural training and some information on SW-C products.

Table 2.6-3 Manure and SW-C Promotion Program for Awareness

Survey Site	% HHs Reporting Manure Program	% HHs Reporting Source of Information*				% HHs Reporting SW-C Program	% HHs Reporting Type of SW-C Program**				% HHs Reporting Attending Manure Training	% HHs Reporting SW-C Training
		1	2	3	4		1	2	3	4		
KMC Average	37.5	50.0	12.5	12.5	0.0	12.5	12.5	0.0	0.0	0.0	37.5	25.0
LSMC Average	100.0	100.0	50.0	0.0	0.0	0.0	0.0	37.5	0.0	0.0	87.5	0.0
BKM Average	75.0	75.0	37.5	50.0	0.0	25.0	25.0	0.0	0.0	0.0	25.0	12.5
MTM Average	0.0	0.0	0.0	0.0	0.0	25.0	12.5	12.5	12.5	0.0	12.5	12.5
KRM Average	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0	0.0
Dhading Average	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kavre Average	20.0	0.0	0.0	0.0	30.0	0.0	0.0	0.0	0.0	0.0	10.0	10.0
Valley Average	42.5	45.0	20.0	12.5	0.0	12.5	10.0	10.0	2.5	0.0	37.5	10.0
Outside Valley Average	15.0	0.0	0.0	0.0	15.0	0.0	0.0	0.0	0.0	0.0	5.0	5.0
Overall Average	33.3	30.0	13.3	8.3	5.0	8.3	6.7	6.7	1.7	0.0	26.7	8.3

Source: Household Survey, November 2004
Note: * 1. Agriculture Extension Agent, 2. Nepal TV, 3. Group Discussion, 4. Gobar Gas Program
** 1. Women Dev. Group, 2. Municpality Authority/VDC Authority, 3. NGo/INGO and 4. Others

2.6.4 Replacement of Fertilizer and Manure by SW-C

The possible replacements of fertilizers and manure by SW-C are presented in the Table 2.6-4. About 43% households reported that less than 20% fertilizer can be replaced by SW-C and about 18% responded 20 to 30% replacement could be done and some of the household reported that SW-C can replace put 40 to 50%. In the same way, 47% households expressed opinion that SW-C will replace about 20% of fertilizer use and some others (27%) anticipated 20 to 30 % replacement.

Table 2.6-4 Replacement of Manure and Fertilizer by SW-C

Survey Site	% HHs Responding Possible Replacement of Manure by SW-Compost					% HHs Responding Possible Replacement of Fertilizers by SW-Compost				
	Upto 20	20-30	30-40	40-50	No Answer	Upto 20	20-30	30-40	40-50	No Answer
KMC Average	25.0	25.0	0.0	50.0	0.0	62.5	25.0	0.0	0.0	12.5
LSMC Average	37.5	12.5	0.0	50.0	0.0	50.0	0.0	0.0	50.0	0.0
BKM Average	50.0	12.5	12.5	25.0	0.0	37.5	50.0	0.0	12.5	0.0
MTM Average	37.5	12.5	37.5	12.5	0.0	50.0	37.5	0.0	12.5	0.0
KRM Average	12.5	12.5	25.0	50.0	0.0	0.0	12.5	12.5	75.0	0.0
Dhading Average	40.0	40.0	0.0	10.0	10.0	20.0	60.0	10.0	0.0	10.0
Kavre Average	90.0	10.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
Valley Average	32.5	15.0	15.0	37.5	0.0	40.0	25.0	2.5	30.0	2.5
Outside Valley Average	65.0	25.0	0.0	5.0	5.0	60.0	30.0	5.0	0.0	5.0
Overall Average	43.3	18.3	10.0	26.7	1.7	46.7	26.7	3.3	20.0	3.3

Source: Household Survey, November 2004

2.6.5 Nutrients or Fertilizer Requirement of Major Crops

Recommended Crop Nutrients of Major Crops

The recommended doses of crop nutrients rate and compost is presented below, in the Table 2.6-5 to 2.6-9. To harvest good crop one has to supplement optimum dose of plant nutrients depending on crop demand or as per crops' requirement. The recommended dose of different crops as recommended by Nepal Agriculture Research Council (NARC) is presented in the Table 2.6-5 (a).

Fertilizer Consumption in the Survey Districts

The consumption of chemical fertilizers in the survey area is presented in Table 2.6.5 and fertilizer use rate (kg/year/ha) is presented in Table 2.6.7.

Table 2.6-5 Nutrients or Fertilizer Requirement of some Major Crops

Crops	Recommended Rate of Nutrients (kg/ha)				Computed Fertilizers Rate (kg/ha)		
	N	P_2O_5	K_2O	Compost	Urea	DAP	Potash
Paddy	100	30	30	6,000	192	65	50
Wheat	100	50	25	6,000	175	109	42
Maize	60	30	30	6,000	105	65	50
Oilcrops	60	40	20	6,000	96	87	33
Potato	70	50	40	30,000	110	109	67
Vegetables	70	50	40	30,000	110	109	67

Source: Nepal Agriculture Research Council (NARC), Nepal

Table 2.6-6 Fertilizer Consumption in the Survey Area in Last Five Years

(Unit: Tons)

Fiscal Year	Fertilizer	Kavre	Bhaktapur	Lalitpur	Kathmandu	Dhading	Central Dev. Region
FY1998/99	Urea	3662	NA	NA	5211	752	26483
	DAP	1235	NA	NA	951	168	8991
	Potash	154	NA	NA	61	5	801
FY1999/00	Urea	2308	NA	NA	4039	540	21665
	DAP	1780	NA	NA	1448	189	9651
	Potash	35	NA	NA	48	4	141
FY2000/01	Urea	1163	NA	NA	2079	480	11348
	DAP	1320	NA	NA	958	110	6714
	Potash	0	NA	NA	0	0	28
FY2001/02	Urea	307	NA	NA	1921	61	5283
	DAP	1218	NA	NA	1325	129	7913
	Potash	59	NA	NA	54	0	349
FY2002/03	Urea	3147	NA	NA	5103	75	17035
	DAP	990	NA	NA	2916	171	13803
	Potash	275	NA	NA	193	4	1326

Note: NA=Not available
Source: Statistical Information on Nepalese Agriculture, A-BPSD, MOAC, HMG/N, 2002/2003

Table 2.6-7 Fertilizer Consumption in the Survey District

(Unit: kg/year/ha)

Fiscal Year	Fertilizer	Kavre	Kathmandu	Lalitpur	Bhaktapur	Dhading	Central Dev. Reg.
FY 1998/99	Urea	76	27	NA	NA	21	33
	DAP	26	5	NA	NA	5	11
	Potash	3	0	NA	NA	0	1
FY 1999/00	Urea	48	21	NA	NA	15	27
	DAP	37	8	NA	NA	5	12
	Potash	1	0	NA	NA	0	0
FY 2000/01	Urea	24	11	NA	NA	14	14
	DAP	27	5	NA	NA	3	8
	Potash	0	0	NA	NA	0	0
FY 2001/02	Urea	6	10	NA	NA	2	7
	DAP	25	7	NA	NA	4	10
	Potash	1	0	NA	NA	0	0
FY 2002/03	Urea	65	27	NA	NA	2	22
	DAP	20	15	NA	NA	5	17
	Potash	6	1	NA	NA	0	2

Note: NA=Not available.

Fertilizer Prices at National

The national fertilizer prices are presented in Table 2.6-8 and price index in Table 2.6-9. The price of fertilizer has jumped up unto 10 times in DAP and about two times in Urea and one and half times in Potash in 2002/03 compared to 1998/99 cost.

Table 2.6-8 Sale Prices of Chemical Fertilizers

(Unit: NRs./Ton)

Fertilizer	1998/99	1999/2000	2000/01	2001/02	2002/2003
A. Sulphate	6,900	11,000	10,300		
Complex	10,000			19,300	19,300
Urea	7,400	9,640	13,980	14,100	14,100
T.S.P	8,000				
Potash	9,350	13,900	18,540	13,600	14,325
D.A.P	18,570	20,400	19,500	19,000	193,325

Source: Statistical Information on Nepalese Agriculture, A-BPSD, MOAC, HMG/N, 2002/2003

Table 2.6-9 Fertilizer Price Index (1998/99 Price = 100)

(Unit: %)

Fertilizer	1998/99	1999/2000	2000/01	2001/02	2002/03
A. Sulphate	100	159	149	0	0
Complex	100	0	0	193	193
Urea	100	130	189	191	191
T.S.P	100	0	0	0	0
Potash	100	149	198	145	153
D.A.P	100	110	105	102	1041

2.6.6 Prices of Manure and SW-C in the Survey Area

Prevailing prices of manure and proposed price of SW-C is presented in the Table 2.6-10. The average present price of manure is reported as NRs.1.10/kg and for SW-C as Rs 2.21/kg. There is little confusion between SW-C and compost produced by private agencies because the SW-C produced by BKM does not cost more than Rs 0.20/kg while compost sold by private agencies that cost more than NRs.4.0 and goes up to NRs.15/kg depending on the individual's products. The suggested price of SW-C by farm households is Rs 1.08/kg.

Table 2.6-10 Prices of Manure and Solid Waste Compost

Survey Site	Manure Price (NRs./kg)		SW-C Price (NRs./kg)	
	Present Price	Proposed Price	Present Price	Proposed Price
KMC Average	1.0	1.0	3.20	1.25
KRM Average	1.2	0.9	2.43	2.03
LSMC Average	0.5	0.5	0.50	1.19
BKM Average	0.8	1.0	0.29	0.87
MTM Average	2.3	1.7	0.33	1.06
Dhading Average	1.0	1.2	1.00	1.00
Kavre Average	0.8	0.9	1.50	0.46
Valley Average	1.2	1.0	1.21	1.24
Outside Valley Average	0.9	1.0	1.25	0.73
Overall Average	1.1	1.0	1.21	1.08

Source: Household Survey, November 2004

Market Price of Fertilizer in the Districts

Agriculture Inputs Company has fixed the prices of fertilizer to each district depending on the transportation cost and other official cost. The district prices of fertilizer for the survey districts are presented in Table 2.6-11.

Table 2.6-11 Market Price of Fertilizer in the Districts

Fertilizer	Fertilizer Price (NRs./Ton)		
	Dhading District	Kavre District	Kathmandu Valley
Urea	15,120	15,440	15,320
DAP	22,320	22,640	22,520
Potash	14,100	14,350	14,300

Source: Agriculture Input Company, Teku

2.6.7 Problems Encountered in SW-C Use

Farmers are not aware of SW-C products, mainly on its quality, marketing, prices and its effect on crop production. Only 3.3% of the households have expressed about the availability SW-C and rest of the households do no have idea about SW-C. As reported by the farmers, the reasons for not applying SW-C is unaware of product, unavailability of products and quality of product are not of farmer preference.

Table 2.6-12 Problems Encountered in SW-C Use

Survey Site	% HHs Responding Availability of SW-C	% HHs Responding on the Problems Faced in Using SW-C				
		1	2	3	4	5
KMC Average	0.0	75.0	62.5	25.0	0.0	25.0
LSMC Average	0.0	12.5	0.0	0.0	0.0	87.5
BKM Average	0.0	12.5	62.5	25.0	0.0	25.0
MTM Average	12.5	37.5	37.5	12.5	12.5	25.0
KRM Average	12.5	37.5	12.5	12.5	0.0	62.5
Dhading Average	0.0	20.0	30.0	0.0	0.0	60.0
Kavre Average	0.0	0.0	0.0	0.0	0.0	100.0
Valley Average	5.0	35.0	35.0	15.0	2.5	45.0
Outside Valley Average	0.0	10.0	15.0	0.0	0.0	80.0
Overall Average	3.3	26.7	28.3	10.0	1.7	56.7

Note: Reasons of Problems, 1. Not available, 2. Not to the quality, 3. Lack of knowledge about SW-C , 4. Others and 5. No Response
Source: Household Survey, November 2004

2.6.8 Farmers' Opinion on SW-C Marketing

For the promotion marketing, 28% reported better to prepare SW-C, 10% suggested people awareness program should be initiated and 43% emphasized on quality product with low product price.

Households report numerous suggestions regarding SW-C. 23% of households reported quality SW-C will improve soil fertility (better plant nutrient value), 15% expressed better SW-C will increase crop production a 20% households further emphasized on quality product and it should not carry any infectious plant diseases and insect inoculums.

Table 2.6-13 Farmers' Opinion on SW-C Marketing

Survey Site	% HHs Reporting Future Marketing of SWP-C*						% HHs Reporting Comment/ Suggestions on SWP-C**				
	1	2	3	4	5	6	1	2	3	4	5
KMC Average	100.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
LSMC Average	25.0	0.0	50.0	25.0	12.5	12.5	25.0	0.0	12.5	0.0	37.5
BKM Average	62.5	12.5	25.0	37.5	12.5	0.0	12.5	0.0	12.5	25.0	37.5
MTM Average	0.0	0.0	87.5	25.0	0.0	0.0	0.0	0.0	25.0	0.0	12.5
KRM Average	25.0	12.5	12.5	25.0	12.5	0.0	37.5	12.5	50.0	25.0	12.5
Dhading Average	0.0	10.0	70.0	20.0	10.0	0.0	0.0	0.0	10.0	10.0	30.0
Kavre Average	0.0	30.0	50.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	10.0
Valley Average	42.5	5.0	35.0	22.5	7.5	2.5	35.0	2.5	20.0	10.0	20.0
Outside Valley Average	0.0	20.0	60.0	10.0	10.0	0.0	0.0	0.0	5.0	5.0	20.0
Overall Average	28.3	10.0	43.3	18.3	8.3	1.7	23.3	1.7	15.0	8.3	20.0

Note: * 1. Better to prepare SW-C, 2. Awareness to people, 3. Low price and good quality, 4. Environmentally friendly, 5. Reduce fertilizer use and Others.
Note: ** 1. Improves soil fertility, 2. High nutrient value, 3. Increase production, 4. Lack o awareness and 5. Quality product and resist to insects and diseases.
Source: Household Survey, November 2004

Chapter 3 Assessment of Solid Waste Compost Product and Market

3.1 Quality of Solid Waste Produced in Kathmandu Valley

The composition of solid waste materials varies from source of collection as household waste, industrial waste, street waste and others. If it is watched very closely, the quality of waste differs from one area to other depending on the standard of living of the people and ethnic groups. The composition reported by different studies differs to one to other. The solid waste composition reported by Municipality is taken as a standard, and mean is computed to have general understanding of valley waste quality (Table 3.1-1). The average kitchen waste or organic waste is estimated at 72.5% but it varied from 67.5% to 76.0% from one municipality to other. The solid waste component and composition reported by UNEP (2001) is presented in Table 3.1-2 and composition of waste surveyed by the JICA Study Team is given in Table 3.1-3. The graphic presentation of composition of solid waste produced in the Kathmandu Valley by municipality is illustrated in the Figure 3.1-1.

Table 3.1-1 Quality of Solid Waste Composition in the Kathmandu Valley

Waste Materials	% Composition of Solid Waste (in weight basis)					
	KMC	LSMC	BKM	MTM	KRM	Mean
Kitchen waste	70.00	67.50	76.00	75.00	74.00	72.50
Paper	9.00	8.80	3.25	6.00	5.70	6.55
Textile	3.00	3.60	3.00	0.00	0.80	2.08
Wood/leaves	0.00	0.60	0.00	0.00	0.09	0.14
Plastic	9.00	11.40	3.40	5.00	8.80	7.52
Rubber/ Leather	1.00	0.30	0.00	2.00	2.52	1.16
Metal	1.00	0.90	0.30	3.00	1.90	1.42
Glass	3.00	1.60	1.50	2.00	2.90	2.20
Ceramics	0.00	0.00	0.00	0.00	0.00	0.00
Others	4.00	5.30	12.55	7.00	3.29	6.43
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Final Report of Solid Waste Quantity and Quality Survey-Master Plan
Survey on Solid Waste Management for the Kathmandu Valley, May 2004

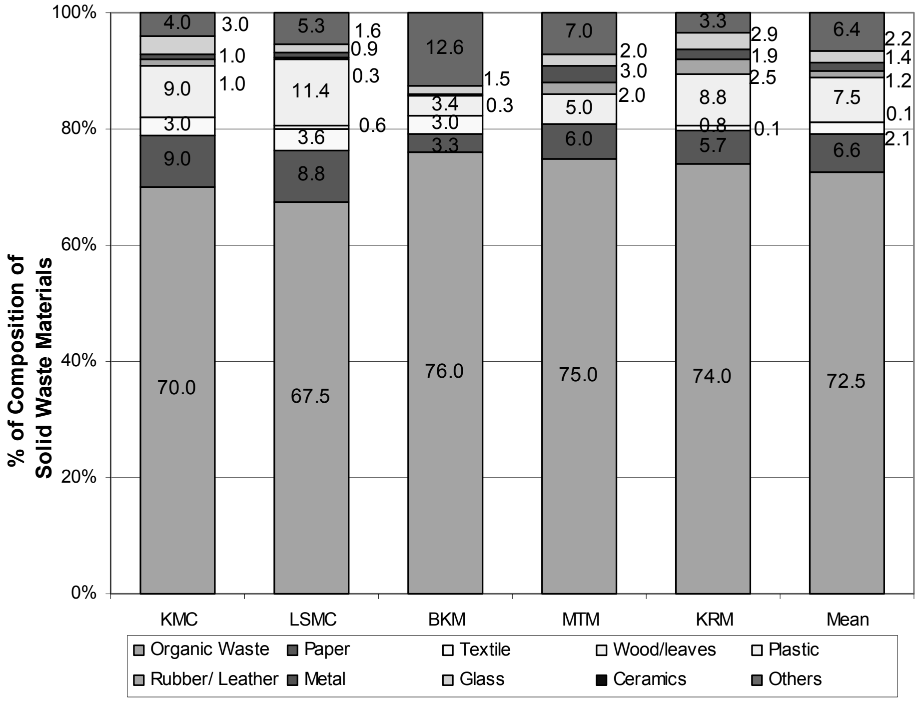


Figure 3.1-1 Composition of Solid Waste Collected in the Kathmandu Valley by Municipality

Table 3.1-2 Composition of Waste Materials in Kathmandu as Reported by UNEP

Waste Materials	% of Waste Materials (by weight basis)			
	1985	1988	1995	1999
Organic Materials	67.5	58.1	65.0	67.5
Paper	6.0	6.2	4.0	8.8
Textile	2.7	2.0	3.0	3.6
Wood/leaves	0.0	0.5	3.0	0.6
Plastic	2.6	2.0	5.0	11.4
Rubber/ Leather	0.0	0.4	1.0	0.3
Metal	2.2	0.4	1.0	0.9
Glass	4.0	1.6	1.0	1.6
Ceramics	0.0	0.0	0.0	0.0
Others (dust, Debris)	15.0	28.9	17.0	5.3
Total	100.0	100.1	100.0	100.0

Source: UNEP, 2001

Table 3.1-3 Solid Waste Composition Surveyed by the JICA Study Team

Waste Materials	% Waste Composition of Households (by weight basis)						
	KMC	LSMC	BKM	KRM	MTM	Mean	Extrapolated to 100%
Garbage	72.3	69.0	84.0	87.0	74.0	77.3	79.6
Paper	11.7	6.0	6.0	3.0	1.0	5.5	5.7
Textile	2.6	3.0	1.0	3.0	0.0	1.9	2.0
Wood/leaves	3.0	12.0	1.0	0.0	0.0	3.2	3.3
Plastic	7.7	12.0	7.0	7.0	4.0	7.5	7.8
Rubber/ Leather	2.3	0.0	0.0	0.0	0.0	0.5	0.5
Metal	0.4	2.0	0.0	0.0	0.0	0.5	0.5
Glass	0.0	2.0	0.0	0.0	1.0	0.6	0.6
Ceramics	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	100.0	106.0	99.0	100.0	80.0	97.0	100.0

Source: JICA Study Team (Weekdays)

3.2 Projected Population of Kathmandu Valley

The growing populations are the main agent for increasing solid waste materials. The projected population for the municipalities and the Kathmandu Valley is presented in Table 3.2-1. The population of urban area is increasing drastically while VDC has less than 1.0% growth. The population growth scenario shows that the municipality population will be doubled in 22 years and valley population by 27 years, consequently waste generation will increased greater than population rate. The population of past Census years (three census years), cultivated area and vegetable areas in the survey districts are presented in the Table 3.2-2. The cultivated areas in the Valley districts are 45,607 ha (31,877 ha for cereal crops, 10,235 for vegetables and 3,495 ha for potato crop).

Table 3.2-1 Populations of Kathmandu Valley (Municipalities and VDCs)

Municipality	Actual Population (Nos.) (2001)	Projected Population (Nos.)			Annual Growth Rate (%)	
		2006	2011	2015	2001-2010 (2058-2067)	2011-2015 (2068-2072)
KMC	671,846	791,028	931,352	1,055,591	3.32	3.18
LSMC	162,991	193,022	228,586	260,790	3.44	3.35
BKM	72,543	86,242	102,527	117,380	3.52	3.44
MTM	47,751	58,348	71,297	83,696	4.09	4.09
KRM	40,835	45,240	50,120	54,400	2.07	2.07
Total Municipality	995,966	1,173,880	1,383,882	1,571,857	3.24	3.24
VDCs	525,498	550,938	584,019	603,891	0.95	0.84
Total Valley	1,521,464	1,724,817	1,959,322	2,175,748	2.61	2.54

Source: JICA Study Team

Table 3.2-2 District Population, Cultivated Area and Vegetable Areas

District	Population in Census Years			Area in Sq. kms	Cultivated Land (ha)	Cereal Crops Area (ha)	Veg Area (ha)	Potato Area (ha)
	1981	1991	2001					
Kathmandu	442,237	675,341	1,081,845	395	19,205	14,580	3,030	1,595
Lalitpur	184,341	257,086	337,785	385	15,296	11,391	3,055	850
Bhaktapur	159,767	172,952	225,461	119	11,106	5,906	4,150	1,050
Total	786,345	1,105,379	1,645,091	899	45,607	31,877	10,235	3,495

Note: Vegetable includes vegetables and potato.
Source: Statistical Information on Nepalese Agriculture, Agi-business Promotion and Statistics Division, MOAC, HMG/N, 2002/2003.

3.3 Quantity of Waste Production in Kathmandu Valley

Table 3.3-1 is computed based on the municipality data and waste projection is done based on the population growth. Table 3.3-2 is estimated based on the JICA Survey data and waste projection as per population growth and some estimated index.

Table 3.3-1 shows the quantity of solid waste produced in the municipalities, projected waste increase, projected total waste production per day and projected annual production of waste in the municipalities. The total waste production is estimated as 780 Tons/per days in the municipality areas and 284,554 tons/year in the year 2015 but at present (2004) it is only 439 Tons/day and 160,235 tons/year. The people associated with solid waste have to take of growing waste by proper management by recycle/reuse and disposal. Reuse may be one of the way to minimize waste for disposal and converting waste matters to compost, because total waste contains about 72% organic waste matters. Tables 3.3-1 and 3.3-2 are prepared from two data sources but the calculated quantum came same, it has hardly differed less than 1%.

Table 3.3-1 Quantity of Waste Production in Kathmandu Valley (based on the Municipality Report)

Municipality	Total Waste Regenerated (Tons/Day)*	Municipal UGR (g/d-capita)				Total Waste Generation in Quantity (Tons/Day)				Total Waste Generation in Quantity (Tons/Year)			
		2004	2006	2011	2015	2004	2006	2011	2015	2004	2006	2011	2015
KMC	300	405	421	465	504	300	333	433	531	109,500	121,658	157,933	193,757
LSMC	90	499	519	573	620	90	100	131	162	32,850	36,576	47,782	59,008
BKM	22	273	284	314	339	22	24	32	40	8,030	8,941	11,726	14,532
MTM	14	260	271	299	323	14	16	21	27	5,110	5,761	7,772	9,876
KRM	13	299	311	343	372	13	14	17	20	4,745	5,137	6,283	7,382
Total	439	1736	1806	1994	2158	439	488	634	780	160,235	178,073	231,497	284,554

Note: * Figures from respecting Municipality

Table 3.3-2 Quantity of Waste Production in the Kathmandu Valley (Based on the Survey Result of JICA Study Team)

Municipality	HHs Unit Generation Rate Waste Generated (gm/day/p)	Additional Index From Comm. Street, VDCs (%)	Municipal UGR (g/d-capita)				Average Daily Waste Generated Quantity (Tons/Day)				Total Waste Generation in Quantity (Tons/Year)			
			2004	2006	2011	2015	2004	2006	2011	2015	2004	2006	2011	2015
KMC	225	85	416	433	478	519	308	342	444	547	112,582	124,962	162,223	199,695
LSMC	225	85	416	433	478	519	75	84	109	135	27,408	30,492	39,834	49,360
BKM	167	90	317	329	363	394	26	28	37	46	9,320	10,349	13,573	16,867
MTM	167	60	267	277	306	332	14	16	22	28	5,252	5,894	7,951	10,142
KRM	167	60	267	277	306	332	12	13	15	18	4,235	4,570	5,590	6,592
Total	190	76	335	350	386	419	435	483	628	774	158,798	176,267	229,172	282,657

Source: JICA Study Team

3.4 Compost Material and Compost Production

3.4.1 Projected Compost Material from Total Solid Waste

The amount of compost materials is estimated from the total solid waste matter that would be generated in future in the municipalities or Kathmandu Urban Areas. The estimation is based on the quality estimated (72.5%) in previous chapter. The projected amount of compost matters from the total waste materials for the year 2006, 2011 and 2015 using two data source is presented in the Table 3.4-1. The compost materials projected for the year 2015 is about 200 thousand tons and 160 thousand tons for the year 2011 and 124 thousand tons for the year 2006. The graphic presentation of projected quantity of compost material production of the Kathmandu Valley up to 2015 is presented in Figure 3.4-1 and Figure 3.4-2.

Table 3.4-1 Projected Compost Materials from Total Solid Waste

Municipality	Projected Compost Materials from Total Solid Waste Matters (Tons)							
	Projected from JICA Study Team Data				Projected from Municipality Data			
	2004	2006	2011	2015	2004	2006	2011	2015
KMC	78,808	87,473	113,556	139,786	76,650	85,161	110,553	135,630
LSMC	18,500	20,582	26,888	33,318	22,174	24,689	32,253	39,830
BKM	7,083	7,865	10,316	12,819	6,103	6,795	8,912	11,044
MTM	3,939	4,420	5,964	7,607	3,833	4,321	5,829	7,407
KRM	3,134	3,382	4,136	4,878	3,511	3,801	4,649	5,463
Total	111,464	123,723	160,860	198,409	112,270	124,767	162,196	199,374

3.4.2 Projected Compost Production from Compost Materials

The projected possible compost production from the solid waste is presented in Table 3.4-2. The projected estimation is computed as 30% compost recovery from compost materials. As estimated as before 72.5% of the total waste is usable for compost production and 30% compost recovery from compost usable materials. In other way, it can be said that about 22.0% compost recovery can be obtained from solid waste. The projected compost production would be 60.0 thousand tons/year in the year 2015, 48.0 thousand Tons in the year 2011 and 37.0 thousand tons in the year 2006, if the composting facilities are well established and better functioned. The graphic presentation of projected quantity of solid waste compost production of the Kathmandu Valley up to 2015 is presented in Figure 3.4-1 and Figure 3.4-2.

Table 3.4-2 Projected Compost Production from Compost Materials

Municipality	Projected Compost Production from Total Solid Waste Matters (Tons)							
	Projected from JICA Study Team Data				Projected from Municipality Data			
	2004	2006	2011	2015	2004	2006	2011	2015
KMC	23,642	26,242	34,067	41,936	22,995	25,548	33,166	40,689
LSMC	5,550	6,175	8,066	9,995	6,652	7,407	9,676	11,949
BKM	2,125	2,360	3,095	3,846	1,831	2,039	2,674	3,313
MTM	1,182	1,326	1,789	2,282	1,150	1,296	1,749	2,222
KRM	940	1,014	1,241	1,463	1,053	1,140	1,395	1,639
Total	33,439	37,117	48,258	59,523	33,681	37,430	48,659	59,812

Note: 30% compost recovery from compost materials (organic waste)

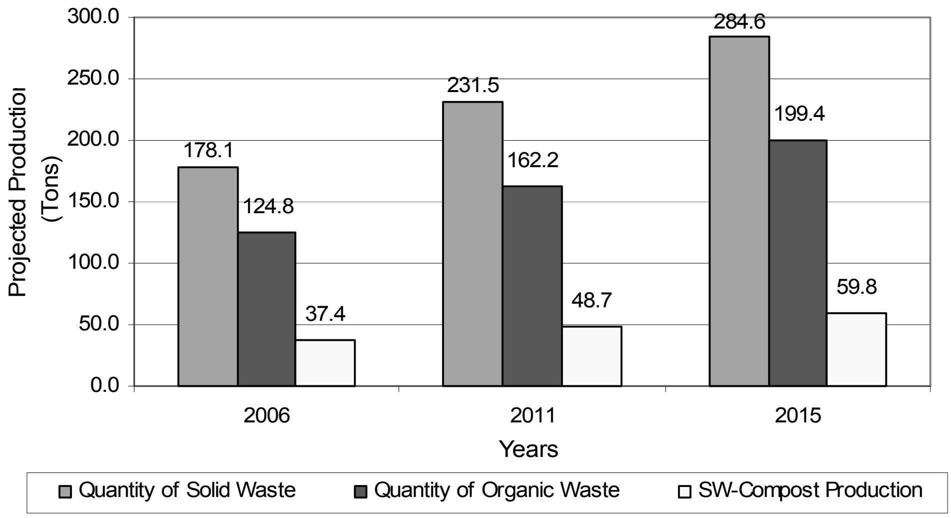


Figure 3.4-1 Projected Solid Waste-Compost Production from Total Solid Waste in the Kathmandu Valley (Municipality Data)

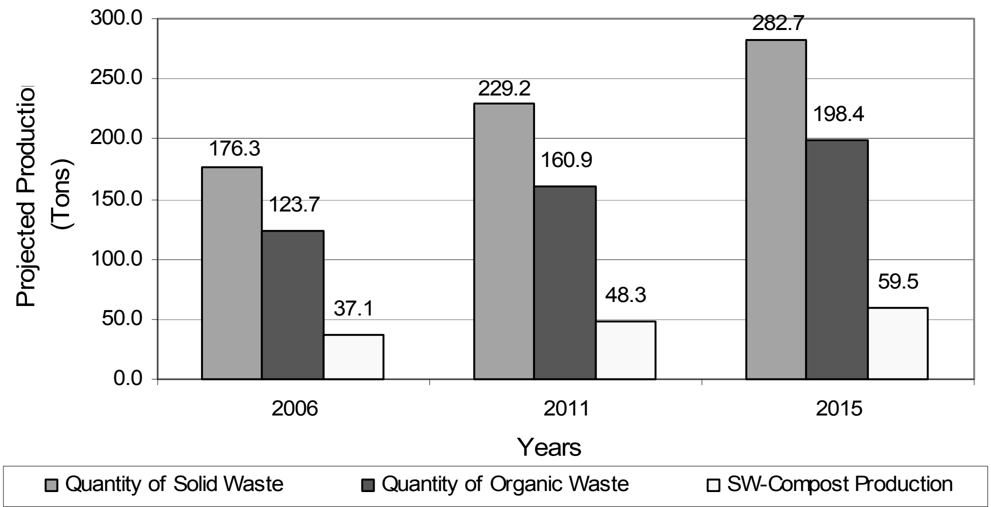


Figure 3.4-2 Projected Solid Waste-Compost Production from Total Solid Waste in the Kathmandu Valley (JICA Study Team Data)

3.5 Quality of SW-Compost

The plant nutrient value of SW-compost product should be of better quality than or it should be at par of manure produced by farmers from Farm Yard Manure (FYM). Quality product should be produced and distribution mechanism should be well developed for its better marketing. The plant nutrient value of manure is presented below (Table 3.5-1):

Table 3.5-1 Nutrient Value of some Manure

Manure/Fertilizer	N (%)	P_2O_5 (%)	K_20 (%)
Cattle Dung Fresh	0.30-0.40	0.10-0.20	0.10-0.30
Poultry Manure (Fresh)	1.0-1.8	1.4-1.8	0.8-0.9
Rural Compost (Dry)	0.50-1.00	0.40-0.80	0.80-1.20
Urban Compost (Dry)	0.70-2.00	0.90-0.30	1.00-2.00
Farm Yard Manure (FYM)	0.40-1.50	0.30-0.90	0.30-1.90

3.6 Comparative Survey of SW-C in the Survey Area among the Users

3.6.1 SW-C User in the Survey Areas

In total 12 households found using SW-C in the survey area. Most of the farmers have leased-in lands for the vegetable cultivation and most of the farmers have found using the SW-C for vegetable cultivation. The total landholding, operational land, total cropped areas using SW-C, total SW-C used in crops and SW-C use (kg/ha/yr) is presented in Table 3.6-1. The operational land is almost double than the landholding of the farmers, which shows that leasing-out and leasing-in land is common practice in survey area, and mostly leased for vegetable cultivation. The average use of SW-C is about 2.5 Tons/ha irrespective of SW-C used to each crop and crop area.

Table 3.6-1 SW-C Users in the Survey Areas

Name of SW-C Users	Landholding (ha)	Operational Land (ha)	SW-C Used		
			Cropped Area (ha)	SW-C Used (kg)	(kg/ha/yr)
Ashtaman Haharjan	0.00	1.050	1.050	560	533
Ganesh Bahadur Kumal	0.35	0.350	0.400	350	875
Lok Bahadur Karki	0.50	0.510	0.500	110	220
Sangita Khanal	0.90	0.900	0.250	50	200
Bhim Bahadu Maharjan	0.13	0.280	0.255	3,650	14,314
Budhi Kumar Tyoyana	0.25	0.850	0.700	200	286
Narayan Bhakta Suwal	0.30	1.000	1.000	150	150
Shri Narayan Bhakta Bake	0.40	0.430	0.225	2,200	9,778
Shri Krishna Kumar Suwal	0.10	0.700	0.300	2,200	7,333
Tulsi Bahadur Tako	0.25	0.250	0.200	3,500	17,500
Tej Krishna Sipahi	0.35	0.350	0.225	370	1,644
Ram Bhakta Sipahi	0.25	0.250	0.275	280	1,018
Total	3.780	6.920	5.380	13,620	2,532

3.6.2 Estimated SW-C Demand in Future

The present manure use and estimated SW-C demand in future is presented in the Table 3.6-2. The present average use rate of SW-C and manure is calculated based on average SW-C and manure use rate and cropped area in weighted basis. The crop area and inputs used (manure and SW-C) are grouped in three as cereal crops (includes all other than vegetables and potato), vegetables and potato. The total crop areas in valley districts is 45,607 ha, where cereal crops area as 31,877 ha, vegetables area as 10,235 ha and potato as 3,495 ha (Table 3.2-2).

In the estimation of future demand of SW-C, 25% of manure presently used could be substituted by SW-C, because the farm households have responded that 25% of their present requirement is met by purchased manure which are brought from other districts or neighboring VDCs. In addition, the farmers (above 98%) have responded that 20% of manure can be replaced by SW-C and above 95% of farmers have expressed their view that SW-C can replace more than 20% of fertilizer requirement. But in the estimation of future demand of SW-C, present use of SW-C and 25% substitution of SW-C is taken in account for estimation. As indicated by the table, the market demand of SW-C will be about 100 thousand Tons and SW-C flow would be about 60 thousand Tons, which is about 60% of the total requirement. If quality SW-C could be produced, that amount will be consumed by farmers for crop production.

Table 3.6-2 Estimated SW-C Demand in Future

Crops	Cropping Area in Valley Districts (ha)*	Present Use		Estimated Demand of SW-C in Future		
		SW-C Use (kg/ha)**	Manure (kg/ha)**	25% Purchased Manure Substituted (Tons)	Present Use (Tons)	Total (Tons)
Cereals	31,877	69	5320	42,396	2,200	44,596
Vegetable	10,235	993	12,016	30,746	10,163	40,909
Potato	3,495	1,491	12,051	10,530	5,211	15,741
Total	45,607			83,672	17,574	101,246

Note: * = Table 4.2(b)
** = Table 3.4-1 (Above figures are grouped in cereals, vegetables and potato, based on crop areas and inputs use rates)

Chapter 4 Conclusions

Quality of SW-C is the main concern for its market. Some of the conclusions drawn in this survey are given below.

- About 95% of the households are using chemical fertilizer, 97% of households are using manure and 20% households are using SW-C product. About 12% households (60% of SW-C user) rated quality of SW-C product as good quality.
- Average use rate of manure is about 5.0 tons/ha in cereals and above 12 tons/ha for potato and vegetables.
- 47% of household area purchasing manure for farming and suggesting that future manure requirement will go up to 78% higher than present use.
- 25% of the manure requirement is met by buying manure from neighboring VDC or adjoining districts and some times from Narayanghat, Chitawan.
- The solid waste production in the year 2015 would be about 282 thousand tons/year (774 Tons/day) and compost materials will be 200 thousand tons/year (organic waste/materials-72.5%) and in total 60 thousand Tons (30% compost recovery) of SW-compost will be produced.
- The recommended rate of manure to cereal crops is 6 tons/ha and 30 tons/ha manure for vegetables and potato.
- The farmers are paying Rs 1.1 for manure and Rs 2.0 for SW-C and farmers are not willing to pay more than Rs 1.0/kg.
- 97% of households responded saying that solid waste management would improve public sanitation, 93% reported SW-compost would improve soil fertility and 67% households suggested it would increase crop production.
- 90% households reported that they are interested in SW-compost and the entire SW-C user expressed that SW-C use will increase in future.
- Majority of households have reported that the rearing of farm animals and production of compost is decreasing but farmers are in favor of applying manure in higher quantity to improve soil fertility and soil health.
- The SW-C produced from solid waste will be easily marketed and will be used by the farmers which ultimately will help to improve public sanitation (public health) and will improve soil fertility and finally enhance agriculture production.
- About 72% of the solid waste materials can be used for compost production (22% of total solid waste), which could be used for crop production.
- The SW-C produced in the plant could be easily sold because produced amount is far below than farmers' demand.
- Quality standard has to be maintained and distribution mechanism has to be well developed. The nutrient value of SW-C should be better or at par with farm houses manure product.
- The suggested price of SW-C is Rs 1.0/kg. As farmers always suggest in lower side, it is suggested that if quality products are produced it could be sold up to Rs 2.0/kg.

Pilot Project B-2

Result of Data Collection
at Bhaktapur Composting Facility

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CHAPTER 1 INTRODUCTION AND BACKGROUND

1.1 Background

In the process of the pilot projects regarding promotion of waste minimization, planning of a large waste minimization facility (composting facility) was conducted. As part of the said pilot projects, a Data Collection Survey of the composting activity by Bhaktapur Municipality at it's Compost Facility (BCF) was carried out.

1.2 Objectives

The objective of the survey is to collect necessary information for developing a large scaled composting facility of municipal solid waste by collecting composting data at Bhaktapur Composting Facility (BCF).

1.3 Scope of Works

Scope of work in Phase I and Phase II of the Study are followings:

The scope of works under Phase I include collection of related information from existing documents and secondary sources covering the following items:

- Design specification of existing composting facility at BKM, capacity, area, process flow, plan drawing and list of facility, processing period, design material balance, necessary human resources for operation,
- Current operation situation
- Operation and Sales record of at least of past 5 years (or as available)
- All past compost quality data (if any)
- Any analyzed data regarding facility of operation
- Comment for BKM compost products by consumers

Scope of works under Phase II included followings:

- Field data collection at composting facility
  Daily monitoring of at least one complete process of composting covering the following items:
  - material balance (incoming waste, compost product, rejected/recycled material, water supply, others including EM solutions if it is used)
  - labor records (number, age, sex, working hour, type of work, others)
  - temperature, moisture content and bulk density of heap of each composting process, every day in first week and every five day from second week,
  - weather, atmospheric temperature and humidity
  - physical composition (wt %, of ten items: garbage, paper, textile, wood, plastic, rubber or leather, metal, glass, ceramic and others) of the waste for composting including moisture contents and bulk density: 4 samples (collected mixed waste before separation at the site, collected mixed waste after the separation at the site, source-separated organic waste and source-separated inorganic waste) for two different days, totally eight samples.
- Analysis of compost product in two samples with items, which includes Organic Component (more than % per dry weight basis), C/N ratio (less than %), Total Nitrogen

(more than % per dry weight basis), Total Potassium (more than % per dry weight basis), Moisture Content (less than % per day weight basis), Electric Conductivity (less than ms/cm), pH (less than dry weight basis), Foreign Particles

- Compost Efficiency Test
- Analysis of results

1.4 Methodology

The methodology adopted for Phase I and subsequently Phase II of the survey was as presented hereunder.

1.4.1 Preparation Work

The Consultant arranged the manpower, equipment and all resources necessary to carryout the Survey works at this stage. A preliminary meeting was held with the Task Group members of Bhaktapur Municipality and other responsible personnel of the municipality in order to carry out the survey work with their active participation. Consultant also prepared necessary checklists and questionnaires, which was used for survey work of Phase I.

1.4.2 Collection of Related Information from Existing Documents and Preparation of Report

As said earlier, Phase I Study was based on basically secondary information. Thus, during this phase of survey, Consultant collected all the information pertaining to the BCF from the concerned officials and staff of Bhaktapur Municipality and other sources. The changed staff of the BCF within the last five years were traced and interviewed to extract relevant past data relating to the BCF. Similarly, customers of compost, who proved to be potential informant for collecting historical as well as present data were contacted and interviewed.

1.4.3 Field Data Collection at the Composting Facility

The field survey at the BCF was carried out for continuous 57 days, i.e., one complete cycle of composting. This task primarily included monitoring of composting facilities and process. Daily monitoring was done by BKM staff, and the Consultant arranged for the necessary equipment and instrument.

The Survey work included followings:

Keep Record of Material Balance: The material balance included taking weight of daily incoming waste in the composting facility and sell of compost, rejected material thrown and recyclable material recovered. The weight was taken by using a truck scale owned by a private party at Sallaghari, Bhaktapur.

Labor Record: Complete record of the staff working at BCF was collected. It included numbers of staff, their age, sex, working hour, type of work and other details with the help ofpre-designed check list and format.

Weather Record: Consultant collected weather data covering weather, atmospheric temperature and humidity, through secondary sources (data recorded at DHM Station at Airport, Kathmandu).

Physical Composition: Physical composition of complete cycle of compost formation from incoming of waste to final compost production was surveyed. For this, two windrows were prepared from incoming waste. One windrow was made of mixed waste in the state it arrived at the composting facility, and the other windrow was made after recovery of recyclable from the waste (plastic, metal, glass).

The waste (both mixed for windrow 1 and segregated for windrow 2) were thoroughly mixed by turning couple of times with spade and formed in to a conical shape. The cone was separated in to four quarters. The opposite two quarters were rejected and remaining two opposite quarters were again mixed and made into conical heap. The process was carried out till 5 kg of waste remained. The remaining sample was weighed and volume measured. The composition of the waste was surveyed. It was done by separating the sample into 10 items: paper, garbage, textile, wood, plastic, rubber & leather, metal, glass, ceramics and others. Their percentage by weight of each component was measured for identifying their percentage by weight. The samples were then dried in oven with constant heat of 100 to 120 degree Celsius for 24 hours. The dried weight was measured and again kept in oven for two more hours. The weight was again measured and compared with previous data to check if it was varying. The process was continued till last two data were constant. Dried weight and volume was measured and dry density of the compost as well as Moisture Content was calculated. Such sampling and testing was done for two sample each for the following types of wastes making it total of 4 samples. Sampling was done two before composting and two after composting.

The physical characteristic of the compost heap was tested. Temperature of the core of the heap was measured by laboratory thermometer (provided by the JICA Study Team). From the core area sample was taken out and measured for finding its bulk density through a Moisture Content Testing equipment. Such test was done everyday in the first week of windrow compost heap preparation, and every five days from the second week for totally 17 times, i.e. composting process of 57 days.

Water sprayed on the windrows was measured volumetrically by lps method and using stop watch to measure time of spraying. Other solutions like EM solution, if used, was also measured volumetrically.

Thereafter, after 57 days of complete composting process, the waste was finally turned and sent for screening. The screening process separated two type of wastes: one for remaining recyclable materials (plastic, paper, metals, tin etc.) and other rejected materials (glass pieces, torn plastics, clothe pieces, construction waste etc.). The weight of both recyclable waste and rejected waste were measured. The remaining waste was final compost.

1.4.4 Quality Analysis of Produced Compost

The sample for testing chemical properties was collected from the finished compost, each from windrow 1 and windrow 2. The samples were collected as per standard procedure and tested in a well equipped chemicals testing laboratory of the National Agriculture Research Council (NARC)/HMG/N. Quality of compost was analyzed for the eight items:

1.4.5 Compost Efficiency Test

The Compost produced at the BCF was used for testing their quality of fertilization efficiency and analyzed through the standard procedure suggested by the National Agriculture Research Center (NARC) of HMG/N, and carried out by a qualified soil scientist. The analysis was based on Field Method.

The Field Experiment for Tomato: the field experiment for an improved variety of tomato has been conducted in RCBD with and without compost. The plots of size (3.5 m X 4 m) were prepared near the composting facility at Byasi, BKM. 20 numbers of tomato plants were planted with four rows at 2.5 m center to center distance. Compost was applied at the rate of 30 ton per ha.

1.4.6 Analysis of Data and Preparation of Report

Analysis of data was done in coordination with BKM's Staff (Mr. Moti Bhakta Shrestha) and other related Nepalese counterpart personnel of the Study. The Survey results were finally analyzed to find the followings:

- Material balance
- Cost analysis for composting activity
- Compost product quality
- Fertilization efficiency of compost product
- Issues on the existing composting process

The entire survey activity and result with conclusion have been prepared in the form of this Final Report.

CHAPTER 2 PHASE I: RESULT OF EXISTING COMPOSTING FACILITY

2.1 Design Specification

2.1.1 General

The Bhaktapur Composting Facility (hereinafter called BCF) was established in 1978 as a part of the Bhaktapur Development Project, which was implemented with the assistance of Germany from 1976 to 1984. The BCF was handed-over to the Bhaktapur Municipality (hereinafter called BKM) in 1984.

There was a gap to produce compost from composting facility since 1984 to 1988. In 1988, the BCF was rehabilitated and some of staffs of Bhaktapur Municipality were trained in the BCF operation with the assistant of German funded Solid Waste Management and Resource Mobilization Centre. Since 1988, the BCF is regularly producing compost till today. The BCF is the only operating composting facility operated by municipality in Nepal.

2.1.2 Location

The BCF is located at Bhelukhel, Ward No. 11 of BKM, which is a neighborhood in the southern part of the city on the northern bank of Hunumante River. The BCF is situated at area mostly inhabited by sweepers. There is a well near the BCF at North-East corner and a stone spout at North-West corner. Locals use these for collecting water, washing cloth and bathing. The sweeper community has kept pigs, who frequently visit the BCF to eat waste brought in the facility. There is some 12 feet wide street on East and North side of the Facility. Open space and river bank exist at Southern side. However, at West side, couple of houses borders with the fence of the BCF. Thus, despite the location of the facility was secluded and away from resident area in the past, at present it is surrounded by residential buildings at two sides (North and West). Open agriculture land exist at East side.

2.1.3 Area

In the beginning, the BCF occupied an area of 2,640 m^2. At present, its area has been expanded at southern part with a total area of 2,902.53 m^2. In the area, 1,537.57 m^2 is brick paved and remaining area of 1,364.96 s m^2 is in the process to be paved. The length of the BCF is 115 m with elongation from south to north. Breadth of the facility is 30 m. at north and 55 m at south. The site is completely surrounded by a masonry boundary wall at all sides. There are two gates. One for selling compost and another for incoming of waste and outgoing of rejected material for disposal. An unloading dock and conveyer is constructed with CGI sheet roofing, the only covered area in the BCF. There are guard house, toilet and bathing room for the labors.

2.1.4 Capacity

At present, daily inflow of mixed waste at the BCF is about 6 ton per day and outflow of compost fertilizer is 1.04 ton per day in an average 22 open stock piling windrow size 20 m x 2 m x 2 m waste can be processed for composting (data of December 24, 2004). The BCF has enough capacity for compost production of 5-6 tones per day.

If the area of the BCF is fully utilized, the compost facility will have the capacity to build at least 40 windrows, while leaving enough space for maturation and storage of finished product. Assuming that the windrows are triangular in cross-section and have the dimensions of 2 m width at the base, 1 m height, and 18 m length, then at any given time, there would be 720 m^3 of windrow space. SWMRMC's experience from Teku indicates that the density of waste in a new windrow is approximately 1.4 times higher than fresh incoming waste (SWMRMC, 1989). Furthermore, if we assume that 15% of incoming waste is rejected, then a total of 1.185 m^3 of fresh waste will be required for the 40 windrows. If the average time required for composting, including maturation is 2 months, then each windrow can be replaced at least 4 times a year, even if no composting is done during the monsoon season. Therefore, if the space is fully utilized, the compost plant will have capacity to utilize 4.740 m^3 of waste per year[1].

2.1.5 Composting Process

Composting is a biological process in which organic wastes are converted into stabilized humus by the activity of complex organism naturally present in waste. The composting process adopted at the BCF is aerobic decomposition method through windrow formation. Aerobic decomposition is most commonly used biological process for conversion of organic portion of municipal solid waste to a stable humus-like material known as *compost*.

(1) Philosophy of Aerobic Decomposition

When organic materials decompose in the presence of oxygen, the process is called "aerobic." There is low bad smell when there is adequate oxygen present.

In aerobic decomposition, living organisms, which use oxygen, feed upon the organic matter. They use the nitrogen, phosphorus, some of the carbon, and other required nutrients. Much of the carbon serves as a source of energy for the organisms and is burned up and respired as carbon dioxide (CO^2). Since carbon serves both as a source of energy and as an element in the cell protoplasm, much more carbon than nitrogen is needed. Generally about two-thirds of carbon is respired as CO^2, while the other third is combined with nitrogen in the living cells. However, if the excess of carbon over nitrogen (C:N ratio) in organic materials being decomposed is too great, biological activity diminishes. Several cycles of organisms are then required to burn most of the carbon.

When some of the organisms die, their stored nitrogen and carbon becomes available to other organisms. As other organisms use the nitrogen from the dead cells to form new cell material, once more excess carbon is converted to CO^2. Thus, the amount of carbon is reduced and the limited amount of nitrogen is recycled. Finally, when the ratio of available carbon to available nitrogen is in sufficient balance, nitrogen is released as ammonia. Under favorable conditions, some ammonia may oxidize to nitrate. Phosphorus, potash, and various micro-nutrients are also essential for biological growth. These are normally present in more than adequate amounts in compostable materials and present no problem.

During composting a great deal of energy is released in the form of heat in the oxidation of the carbon to CO^2. For example, if a gram-molecule of glucose is dissimilated under aerobic conditions, 484 to 674 kilogram calories (kcal) of heat may be released. If the organic

[1] Technical and Economic Analysis of Bhaktapur Compost Plant- Nepal, UWEP, 1997

material is in a pile or is otherwise arranged to provide some insulation, the temperature of the material during decomposition will rise to over 170°F. If the temperature exceeds 162°F to 172°F, however, the bacterial activity is decreased and stabilization is slowed down.

Initially, mesophilic organisms, which live in temperatures of 50°F to 115°F, colonize in the materials. When the temperature exceeds about 120°F, thermophilic organisms, which grow and thrive in the temperature range 115°F to 160°F., develop and replace the mesophilic bacteria in the decomposition material. Only a few groups of thermophiles carry on any activity above 160°F.

Oxidation at thermophilic temperatures takes place more rapidly than at mesophilic temperatures and, hence, a shorter time is required for decomposition (stabilization). The high temperatures will destroy pathogenic bacteria, protozoa (microscopic one-celled animals), and weed seeds, which are detrimental to health or agriculture when the final compost is used.

Aerobic oxidation of organic matter produces no objectionable odor. If odors are noticeable, either the process is not entirely aerobic or there are some special conditions or materials present which are creating an odor. Aerobic decomposition or composting can be accomplished in pits, bins, stacks, or piles, if adequate oxygen is provided. Turning the material at intervals or other techniques for adding oxygen is useful in maintaining aerobic conditions.

Compost piles under aerobic conditions attain a temperature of 140°F to 160°F in one to five days depending upon the material and the condition of the composting operation. This temperature can also be maintained for several days before further aeration. The heat necessary to produce and maintain this temperature must come from aerobic decomposition which requires oxygen. After a period of time, the material will become anaerobic unless it is aerated.

(2) Composting Process at the BCF

The process of composting at the BCF is as presented hereunder:

Collection and Transportation of Waste:

Waste is collected from households and street side. This implies that the waste transported to the BCF as feed stock is entirely municipal waste including household waste and street side waste. Rice husk, straw or other materials are not mixed with the waste while making compost. Collected waste is transported to the BCF depending upon the need of the facility to prepare compost and for dumping of waste when vehicles cannot reach at the existing waste dumping sites of the municipality during rainy season. This means that the BCF area is used not only with prime objective of preparing compost but also to dump waste during rainy season.

The BCF has a concrete paved unloading dock. Previously, the tractor loads of incoming waste were dumped before being shoveled into the hopper which led to a conveyor belt. At the front of the belt there was a chopper which reduced the size of the waste as it moved on to the belt. The 10 m long and 0.5 m wide belt was meant for assisting in sorting of the waste. However, the system has been out of operation almost since its initiation. Thus, at present, waste is not sorted mechanically, but manually by turning the heap.

The unloading dock has an area of 20 m^2. The entire area comprising of the unloading dock and the conveyor is under a metal shed. The total area covered by the shed is 110 m^2.

Initial segregation / sorting:

Once the waste is unloaded at the BCF, initial sorting is carried out manually recovering recyclables (plastic, metal and glass). The recyclables thus collected is not property of the BCF but of the labors working there. However, as sorting is not complete, windrows still contains contaminants, mainly plastics, rocks, and some pieces of glass.

Placing waste in Windrow:

The waste after segregation is then placed in as windrow on open and brick paved surface. Each paved row are 2 m wide and 18 m long. The windrows are built on three brick paved platforms and on empty spaces towards the south of plant. The windrow platforms have drains separating each windrow. Each of the three platforms can accommodate six windrows, which are 2 m wide at the base, 1 m high and 18 m long. The area south of the third platform can accommodate 8 additional windrows. The technology adopted is of traditional open stock piling method.

Sprinkling of Water:

Water is sprinkled on the windrows. However, there is no control mechanism to decide volume of water to be added in windrows in order to control temperature and moisture. Practice is, if the windrow is wet, pigs and dogs will not disturb them. Labors also put water to keep the windrow moist.

Water is sprayed on the windrow pile one-to-two times according to state of moisture of the waste, which is judged visually through the experienced eyes of labors. During the wet season (June-August) water is not added to the windrows. In the dry season, water is sometimes sprinkled on the windrows, however not at a regular interval. The temperature and moisture content of the decaying material is never checked.

Addition of EM Solution:

EM (effective micro-organism) solution is sometime added on windrow, whenever budget is available for purchase of the solution. One liter of EM solution is mixed with 200 liter of water in a container. Then electric water motor is used to spray the solution on windrow pile.

However, labors, based on their experience, have reported that addition of EM solution does not make any difference such as faster compost production or better quality of compost. Thus, they are not encouraged in addition of EM solution.

Turning of Windrow:

The only method for aeration used at the facility is turning of the windrows. After a week of formation, turning of the windrow starts for purpose of aeration. Turning is done manually by moving waste in longitudinal direction. Turning is done three times during the initial four weeks.

Recovery of Recyclable and Reject Material:

During each turning process, large particles such as bricks, stones, glasses, bottles, plastics as well as other non-decomposable materials are sorted out.

Because the incoming waste is not properly sorted before it is placed on the windrows, it contains a lot of contaminants. Some sorting is done while turning the pile. This level of sorting is, however, clearly not enough as large amounts of contaminants remains on the piles even after turning. This system is not efficient because the reject materials continue to occupy valuable space at the compost plant and the need for sorting the waste also slows down the workers.

Maturation of Windrow:

Maturation of a windrow takes about two months.

Screening of Decomposed Windrow Material:

After maturation of windrow, it is finally turned and kept for drying for a few days. Then, the dried material is screened manually by using an inclined static chickenwire-mesh screen with openings of 20 mm size.

Recovery of Recyclable and Reject Material:

Recyclable materials, if any, are again recovered while carrying out screening.

Reject Material:

The residual matter is at first piled up at the BCF site. After substantial amount is piled, it is dumped at nearby river bank or transported to reclaim privately owned lowland, in request of landowner.

The process of composting is also presented in Figure 2.1-1 in the following page.

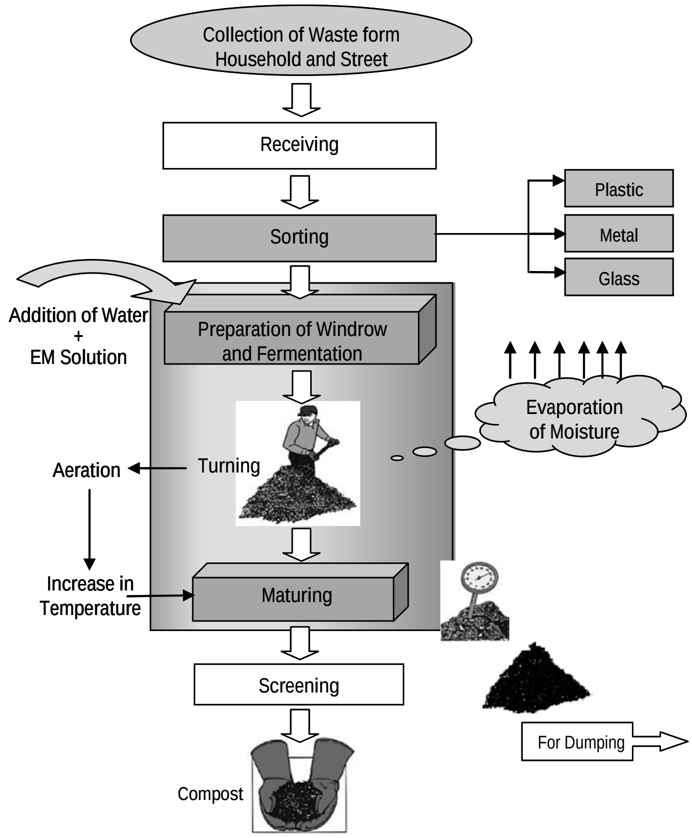


Figure 2.1-1 Composting Process at Bhaktapur Composting Facility

At the BCF, it takes six to nine weeks to make compost from bio-degradable waste. It takes longer time for garbage fermentation in rainy season, as rain falls on the open stock windrow pile. When dry season starts, fermentation of waste proceed faster than rainy seasons. Thus, water is sprayed in dry season on the windrows to maintain moisture. Also, due to open stock, nutrients escape from the compost.

2.1.6 Plan of the Area and Equipment at the BCF

There is surrounding fence all around the BCF with two main gates at each side. A guard house with bathing room equipped with solar water heater is situated at northeast corner along the gate. An out of order conveyor belt with a shade is erected since 1996. The equipment did not function right from its establishment. The conveyor belt was introduced for sorting the organic and inorganic material from incoming waste at the BCF. List of equipments in the compost plant are as follows:

- Electrical Equipment
  - Electrically Operated Sorting Equipment (hereinafter called EOSE) – Conveyor Belt: 1 No. (out of order)
    (established in 1996 for segregation of organic waste, plastics and others by manually, and metals by magnetic separators to harvest good compost)
- Heavy Equipments
  - Backhoe Loader: 1 (Capacity – 6 Ton, KOMATSE, JAPAN) Procured in 1998)
  - Mini Chain Dozer: 1 (Capacity – 6 Ton, KOMATSE, JAPAN)Procured in 1998)
  - Tipper : 2 nos.
- Tools
  - Hand Cart : 4 (capacity: 0.16 m^3)
  - Plastic Buckets : 4 (capacity : 0.01 m^3)
  - Shovel : 14 no
  - Rack : 8 no
  - Pipe : 6 roles (30 mt.)
  - Drum : 3 no (for making E.M solution)
  - Screening Net : 6 no(4 no 5' x 8’, 4 line hole and 1 is 3 line hole size)
  - Water pump : 1 no

2.1.7 Material Balance

Municipal vehicle collects mixed waste from city and transport to the BCF. In year 2003/2004, the total waste transported to the BCF was about 1,752 ton. Similarly, in the year 2004/2005, the total waste transported to the BCF was about 1,012 ton. Thus, with 365 days a year, average waste brought to BCF in 2003/04 and 2004/2005 is 4 ton per day.

For the FY2003/2004 data reveals that compost production was 267 ton and that for FY2004/2005 is 243 ton. The total production in these Fiscal Years was 510 ton.

In rainy season (usually in April-July), as the vehicles cannot move at the dumping areas, most of the collected wastes are transported to compost plant to dump waste as well as prepare compost out of it. Whereas, during dry season, compost prepared in windrows are screened, stored and sold.

Thus, the windrows for preparing compost is generally made immediately before the initiation of monsoon season, i.e. May. Some waste does arrive in the month of December and January. Compost is produced after the windrows reaches maturity in two months after formation of windrow. The windrows are turned finally, dried and screened during the dry months. A trend of incoming of waste (feed stock) for preparation of compost is presented in following Figure 2.1-2.

It is informed by the BKM and the BCF employees that production of compost is about 10% of total yearly production during the months of April, May, June; 10% during months of July and August; 60 % during months of September, October, November and December; and 10 % during the months of January, February and March.

Following Table 2.1-1 and Figure 2.1-2 and Figure 2.1-3 presents the trend of compost production at the BCF, generated according to the information given by the related authorities.

Table 2.1-1 Material Balance Scenario of BCF during the FY2003/2004-2004/2005

(In Ton)

Month	Incoming Waste	Production of Compost	Sell of Compost
FY2003/2004			
Jul-Aug., 2003	510	9	0
Aug-Sept., 2003	442	9	3
Sept-Oct., 2003	155	9	10
Oct.-Nov., 2003	17	13	4
Nov-Dec, 2003	0	13	3
Dec-Jan, 2004	8	40	147
Jan-Feb, 2004	49	40	22
Feb-Mar, 2004	88	40	30
Mar-Apr, 2004	70	40	18
Apr-May, 2004	74	18	23
May-Jun., 2004	129	18	1
Jun-Jul, 2004	210	18	4
TOTAL	1,752	267	265
FY2004/2005			
Jul-Aug., 2004	194	9	2
Aug-Sept., 2004	212	9	1
Sept-Oct., 2004	171	9	1
Oct.-Nov., 2004	211	13	6
Nov-Dec, 2004	95	13	53
Dec-Jan, 2005	41	39	103
Jan-Feb, 2005	1	39	8
Feb-Mar, 2005	1	39	2
Mar-Apr, 2005	39	39	6
Apr-May, 2005	0	17	18
May-Jun., 2005	47	17	7
TOTAL	1,012	243	207

It should be noted that the amount of compost is measured in number of wheel barrow. Thus, several amount are same.

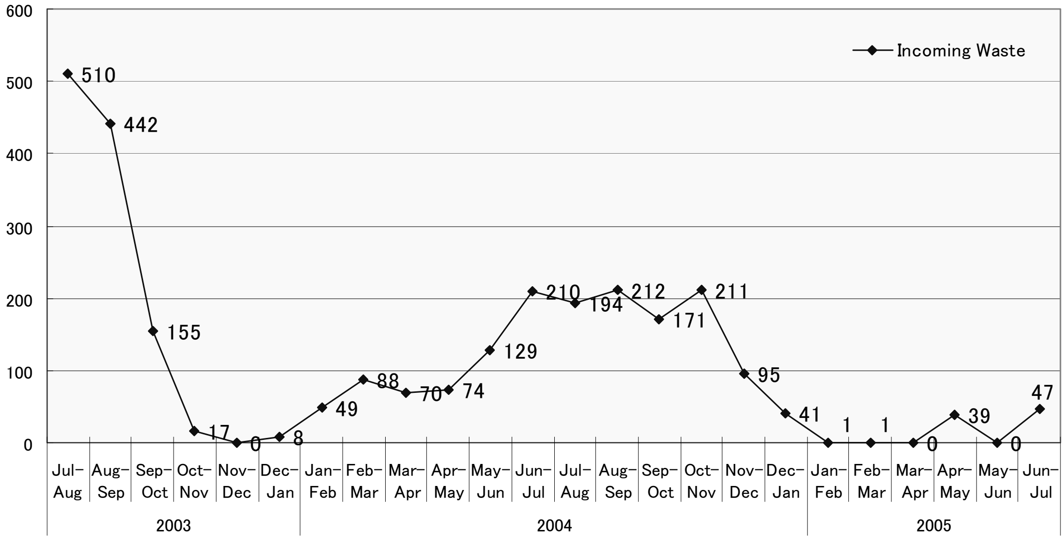


Figure 2.1-2 Incoming Waste at the BCF during FY2003/04-2004/05

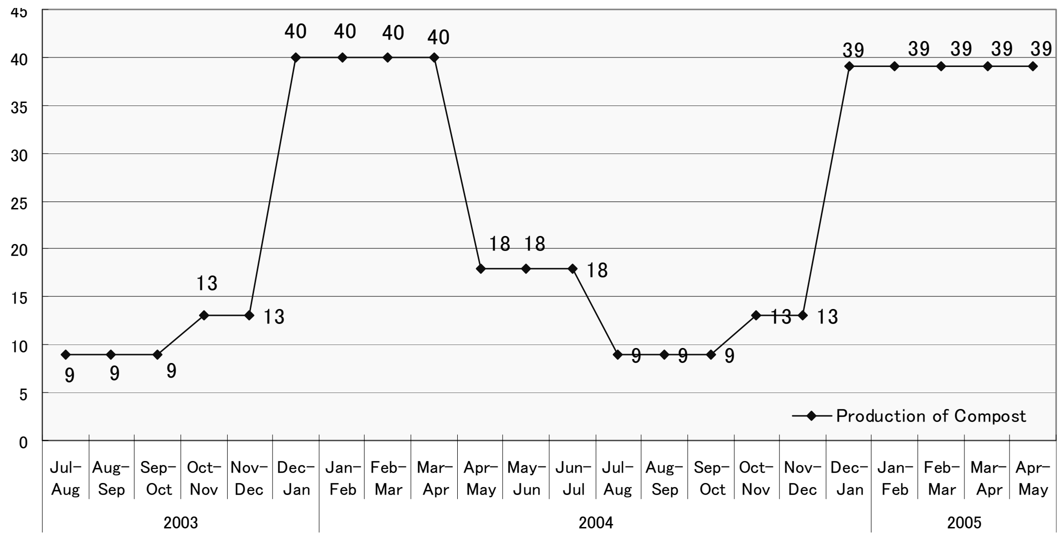


Figure 2.1-3 Compost Production at the BCF during FY2003/04-2004/05

note: the amount of " production of compost" was determined by multiplying the number of trips with the carrying capacity of vehicle; being that every trip carried 100% of the total capacity. Number of trips made was similar for some days.

Following Table 2.1-2 presents the material balance at the BCF taking data of the FY2003/2004 to 2004/2005.

Table 2.1-2 Material Balance at the BCF (FY2003/04 and 2004/2005)

S. No.	Item	Amount (in Ton)	%
1.	Incoming of Waste	1,764	100
2.	Compost Production	510	28.91

Recyclable material sorted at the BCF by the labors is generally plastic, metal and big pieces of glass. It has been reported by the BCF that the labors sold plastic of Rs 3,500 during FY2003/2004 and Rs 2,520 during FY2004/2005. Per kg of plastic is sold in Rs 5 per kg. Thus total plastic recovered can be estimated as 700 kg in FY2003/2004 and 500 kg in

FY2004/2005. Similarly, broken glass of about 8 cu.m was sold in FY2003/2004 in Rs 600 and about 13.6 cu.m. in FY2004/2005 in Rs 1,000.

Rejected material is generally stored at the BCF till it is enough for tripper to carry it out to dump somewhere, at river bank or low lying areas. The total weight of rejected material transported from BCF is as presented in following Table 2.1-3.

Table 2.1-3 Rejected Waste Transported from the BCF

F/Y2002/2003		F/Y2003/2004		F/Y2004/2005	
Month	**Amount(ton)**	**Month**	**Amount(ton)**	**Month**	**Amount(ton)**
Aug	0	Aug	106	Aug	0
Sept	0	Sept	353	Sept	0
Oct	0	Oct	51	Oct	0
Nov	0	Nov	15	Nov	0
Dec	51	Dec	280	Dec	47
Jan	155	Jan	84	Jan	149
Feb	173	Feb	106	Feb	36
Mar	66	Mar	0	Mar	473
Apr	317	Apr	0	Apr	371
May	58	May	0	May	0
Jun	0	Jun	0	Jun	0
Jul	106	Jul	0	Jul	0
Total	926	Total	995	Total	1,076

2.1.8 Human Resources

At the beginning of the establishment of the BCF, 22 sweepers and 2 supervisors were involved in waste management of Bhaktapur Municipality. Waste were collected and transported to the BCF by two tractors and Handcarts. One Lab Supervisor and Lab Assistant were at the lab facility for regular monitoring and evaluation of NPK value, temperature and moisture of compost. A manual rotary screen was also available. Good compost was produced by adding dry sludge from Hanumanghat Sewerage Treatment Plant

Before a year, 16 nos. of workers were involved for compost production at the BCF. Since December 24, 2004, only 14 labors are working at the BCF. They work in two shifts of 6 a.m. to 9 a.m. and from 12 p.m. to 4 p.m. everyday. There is one guard at the BCF.

2.2 Operation Record of Past Five Years

The record of selling compost is collected from selling record data. BKM is selling compost Rs one hundred rupees per tractor (about 700 kg) and Rs 5 per sack of 25 kg.

Table 2.2-1 Operation Situation of BKM Compost Facility

F/Year (in AD)	Compost Produced Per Year		Compost Sell per Year		Recyclable Material sold Per Month in kg.				Remarks
	Wt .in Ton	Rate per kg in Rs	Wt. in Ton	Rate per kg (1 tractor =700 kg)	Plastics	Paper	Metal	Glass	
1998	230	-	196	Rs 0.15	-	-	-	-	
1999	305	-	271	Rs 0.15	-	-	-	-	
2000	285	-	257	Rs 0.15	-	-	-	-	
2001	380	-	344	Rs 0.15	-	-	-	-	
2002	330	3**	295	Rs 0.15	-	-	-	-	
2003	380	3**	352	Rs 0.15	333*	0*	10*	27*	
2004	264		263	Rs 0.14	700*	0*	0*	#	# Half truck load of broken glass (8 cu m) sold by labors in Rs 600.

Note: * No formal notice at office. Labors sell themselves, thus no official record of sell of recyclables.
** Includes only labor charge
One tractor load of compost (700 kg) is sold at present at Rs 100
One sack of compost (25 kg.) is sold at present at Rs 5

BKM is itself using 10 to 20% of compost production for greenery. It does not pay for the compost. Thus, the following Figure 2.2-1 shows the difference between compost production and sell. BKM also transports waste to the BCF when organic matter is found more at garbage collected.

BKM does not have any sanitary landfill site or dumping site. Collected municipal waste carried to the BCF is not only for the purpose of composting, but also assist for receiving most of the garbage disposal in rainy season. From market price of compost of various types, it is found that the compost produced at BCF is comparatively very cheap (see Figure 2.2-2)

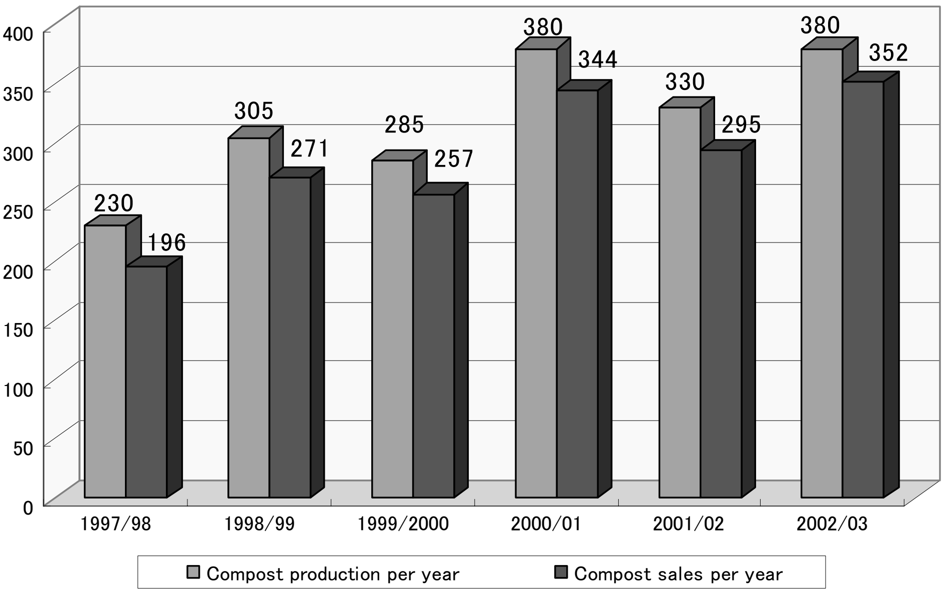


Figure 2.2-1 Operation Situation of BKM Composting Facility

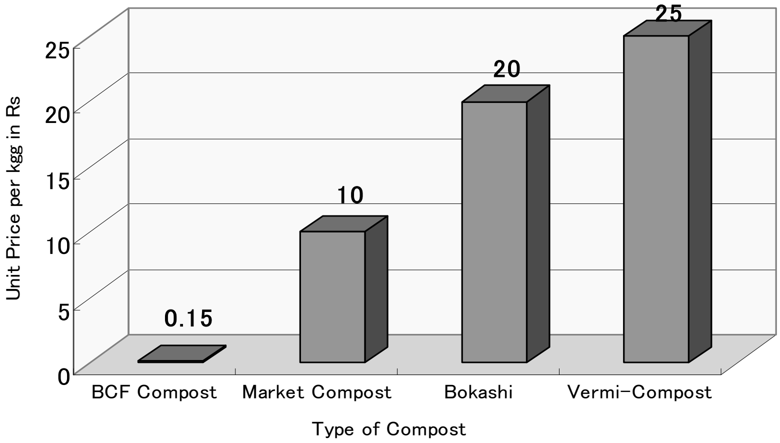


Figure 2.2-2 Price of Compost of Different Types

Source: Market price, 2005

2.3 Past Compost Quality Data

Fresh waste was first analyzed for its composition and quality for compost production by Tabasaran/Bidlingmaier in 1980. From this investigation, 79%-84% of organic matter was found containing mainly straw with cow dung and street sweeping refuse. Although Bhaktapur Municipality does not regularly analyze the quality of compost, whatever compost analysis was done by SWMRMC in May 1989 and UWEP (Urban Waste Expertise Program) in 1997 are presented in the following Table 2.3-1.

Table 2.3-1 Compost Quality

Content	Unit	Result 1 (BCF ,1989)	Result 2 5 months (BCF 1997	Result 3 12 months (BCF 1997)	Proposed Standard Quality4
PH		Na	4.95	5.15	7
N (total)	%	0.71	0.45	0.39	min. 0.8
Phosphorus (P2O5)	%	0.65	0.59	0.56	min. 0.4
Potassium (K2O)	%	0.85	0.95	0.89	min. 0.3
Organic content	%	15	8.11	7.05	min. 18
Organic C (Calc)	%	8.80	4.71	4.10	min. 8.5
Moisture content	%	26	66.3	67.6	Max. 30
C/N – Ratio		12.40	10.51	10.51	min. 12, max. 20
Calcium (Ca)	%	1.50	0.95	0.89	min. 2
Magnesium (Mg)	%	0.53	0.49	0.46	min. 0.4
Boron (B5)	mg/kg	5.40	10-16	Na	Max 25
Zinc (Zn)	mg/kg	270	140-208	Na	Max. 300
Copper (Cu)	mg/kg	120	117-121	Na	Max. 150
Nickel (Ni)	mg/kg	25	32-41	Na	Max. 50
Cadmium (Cd)	mg/kg	< 0.4	0.7-0.8	Na	Max. 5.0
Lead (Pb)	mg/kg	110	73-76	Na	Max. 100
Chromium (Cr)	mg/kg	94	30-36	Na	Max. 100
Mercury (Hg)	mg/kg	0.2	3.6-4.7	Na	Max. 5
Silver (Ag)	mg/kg	3.6	0.7-.09	Na	-
Ferro (Fe)	mg/kg	17,000	8,600-12,400	Na	-
Manganese (Mn)	mg/kg	500	263-290	Na	-
Arsenic		Na	1.7-2.4	Na	-

Note:
1. BCF 1989: Result analysis of BCF compost in 1989 Carried out by SWMRMC Conducted in Germany.
2. 5 months old BCF Compost analysis for this study. The results of the metal content analysis are range of three replicated tests. The nutrient analysis was done at Agricultural technology Center, Lalitpur The metal analysis was done at Environmental and Public Health Organization, Katmandu-(Technical and Economic Analysis of Bhaktapur Compost Plant ,Case-Study Report Composting, 1997.
3. Result of analysis of one year old compost produced by BCF in May 1999,
4. Proposed Compost Standards in sammelband " Muell-und Abfallbeseitigung" by Kumpf/Mass Straub MuA 45 Lf g VIII 1977 code (kennzahl) 6856.pg 13-14 (SWMRMC,1989)

According to above secondary data of past quality analysis of compost, conclusion can be derived as follows:

- Organic content as well as Nitrogen content of compost is low.
- The C: N ratio is slightly low/minimum.
- The level of micro nutrient such as phosphorus, potassium and magnesium are acceptable but calcium content is moderate.
- All heavy metal are far below the maximum content level as indicated in the guideline of standard quality.
- The compost is slightly acidic. Compost with a PH of a little over than 7 should be compatible accordance to soil of the Kathmandu Valley

The high organic content in the municipal waste is ideal for composting. However, the municipal waste stream also contains increasing quantities of glass, plastic, metals and hazardous material, which can contaminate the finished compost. Separating contaminants from the raw material at compost site is inefficient since it requires additional effort, space and time. Source separating the waste before collection is usually environmentally and technically better way to improve the quality of final compost.

2.4 Consumers Response

Farmers are using the BKM compost since more then twenty years before in their main crops as well as cash crops. The productivity was experienced to increase by using compost. In the beginning it was instantly famous calling it as 'Kalo Mal' (black fertilizer). Even today, most of the users or buyers of compost are same farmers. 20 % of buyers are increasing as new user of compost. The quality of BKM compost is thus found to be satisfactory. However, the disappointing factor is compost mixed with small pieces of glass and syringe needle, which makes farmer injured while applying or tending the farm after their use. Some of the users do screens the BKM compost themselves before use. It has been reported that almost one kg of small pieces of glasses can be recovered from one tractor of final compost product.

Following Table 2.4-1 presents the use of compost on main crops by farmers in given area of land.

Table 2.4-1 Use of Compost on Main Crops by Farmers

S. N.	Name of Farmers, Address	Crops	Area in Ropani	Plantation Month (in AD)	Harvesting Month (in AD)	Total Yield kg	Input in kg per Ropani	
							Compost kg.	Fertilizer kg.
1.	DilipKumar Suwal, Bhaktapur, Byasi-15	Paddy	No					
		Wheat	No					
		Maize	No					
		Vegetables	6	Nov-Dec	April-May	12,000	800	50
		Other	No					
2.	Laxmi prasad Twyanabasu Bhaktapur, Kwachhen 11	Paddy	5	Jun-July	Nov-Dec	360		150
		Wheat	No					
		Maize	No					
		Vegetables	1	Nov-Dec	April-May	600	800	50
		Other	No					
3.	Rajendra Prajapati ,Bhaktapur, Suyamadhi -1	Paddy	1	Jun-July	Nov-Dec	300	100 Ash	50
		Wheat	No					
		Maize	No					
		Vegetables	2	Nov-Dec	April-May	840	1200	100
		Other	No					
4	Ram Bhakta Dumaru Bhaktapur, Inacho -6	Paddy	No					
		Wheat	No					
		Maize	No					
		Vegetables	1	Nov-Dec	April-May	600	800	50
		Other	No					
5	Krishna kumar Suwal ,Bhaktapur,14	Paddy	7	Jun-July	Oct - Nov	1750	800	25
		Wheat	3	Nov-Dec	April-May	630	800	25
		Maize	No					
		Vegetables	3	Nov-Dec	April-May	840	1600	15
		Other	No					
6	Krishna Sundar ,Bhaktapur,6 Inanchwo	Paddy	3	Jun-July	Nov-Dec	2250	1600	23
		Wheat	No					
		Maize	1	May-June	Aug - Sept	60	800	10
		Vegetables	0.5	Jan-Feb	April-May	1200	1600	10
		Other	No					
7	Malia khaitu ,Bhaktapur, -12	Paddy	2	Jun-July	Nov-Dec	600	800	50
		Wheat	No					
		Maize	No					
		Vegetables	3	Full year		2400	8000	50
		Other	No					

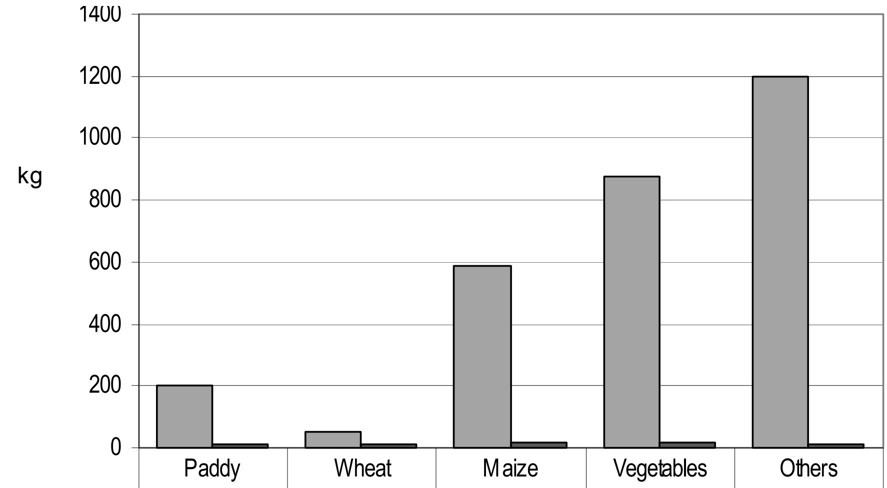
S. N.	Name of Farmers, Address	Crops	Area in Ropani	Plantation Month (in AD)	Harvesting Month (in AD)	Total Yield kg	Input in kg per Ropani	
							Compost kg.	Fertilizer kg.
8	Narayan Bhakta ,Bhaktapur,11 Taumadi	Paddy	6	Jun-July	Nov-Dec	1,800	800	50
		Wheat	3	Nov-Dec	April-May	600		50
		Maize	No					
		Vegetables	3	Sept - Oct	April-May	2,000	1,600	30
		Other	No					
9	Bhakta lal Suwal ,Bhaktapur,11 Khalan	Paddy	2	Jun-July	Nov-Dec	600	2,400	30
		Wheat	1	Nov-Dec	April-May	150	10	20
		Maize	0.75	Jun-July	May-June	60	10	12
		Vegetables	1	Jan-Feb	April-May	750	1,800	50
		Other	No					
10	Laxmi Prasad Twaynabasu ,Bhaktapur,11 Kwachhen	Paddy	6	Jun-July	Nov-Dec	1,800		20
		Wheat	6	Nov-Dec	April-May	1,250		20
		Maize	No					
		Vegetables	0.5	Full year	April-May			10
		Other	2	Dec - Jan		750	2,400	25
11.	Ratan Bhadur chhengutala ,Bhaktapur,13 Kholachhen	Paddy	1	Jun-July	Oct - Nov	200	800	15
		Wheat	No					
		Maize	1	May-June	Aug - Sept	60	800	25
		Vegetables	1.5	Aug - Sept	Nov-Dec	30	30	5
		Other	No					
12	Krishna Chhusyaki ,Bhaktapur,11	Paddy	3	Jun-July	Oct - Nov	750		50
		Wheat	2	Nov-Dec	April-May	300		30
		Maize	No					
		Vegetables	1	Dec - Jan	April-May	1,000	2,400	50
		Other	No					

Note: 1 ha. = 19.6 Ropani

Table 2.4-2 Total Use of Compost by Farmers (Note: 1 ha. = 19.6 Ropani)

	Crops	Area in Ropani	Plantation Month	Harvesting Month	Total Yield kg	Yield kg per Ropani	Input in kg per Ropani	
							Compost	Fertilizer
Total	Paddy	36	Jun - July	Oct – Nov; Nov – Dec	10,410	289	203	13
	Wheat	15	Nov-Dec	April - May	2,930	195	54	10
	Maize	2.75	May-June	Aug - Sept	180	65	585	17
	Vegetables	23.5	All months	All months	22,260	947	878	20
	Other	2	Dec - Jan		750	375	1,200	13
GT		79.25			36,530	374	584	14

The following Figure 2.4-1 compares the efficiency in use of compost versus use of fertilizer as reported by the farmers.



	Paddy	Wheat	Maize	Vegetables	Others
Compost(kg/Ropani)	203	54	585	878	1200
Fertilizer(kg/Ropani)	13	10	17	20	13

Figure 2.4-1 Survey Result on Use of Compost Quantity by Framers

To find out the current consumer response of BKM compost 12 sample surveys has taken from compost using farmers. The survey shows that farmers are using the compost 584 kilogram and 14.22 kg of chemical fertilizer per ropani in main and cash crops. Large amount of compost is used in vegetables farming than main and other crops.

It is found that the compost buyers from the BCF in the year 2003 included followings:

Table 2.4-3 Compost Buyers from the BCF Per Month in Year 2003

S. No.	Buyers of Compost	Buyers No. per month	Weight (kg)	Location
1	Farmers	22	22,583	BKM and surrounding VDCs of Bhaktapur District
2	Nurseries	1	2,000	BKM and surrounding VDCs of Bhaktapur District
3	Vegetable Garden	4	3,750	BKM and surrounding VDCs of Bhaktapur District
4	HMGN Farms	1	100	BKM and Banepa Municipality
5	Others			
	Total	28	28,439	

Source: Sales records from Bhaktapur Municipality for fiscal year 2004

From above table we can see that, total no of user of product of the BCF is 28 in number per month and almost all of compost buyer are local farmers. Above data is derived from sales records from Bhaktapur Municipality fiscal year 2003/04.

2.5 Private Companies Selling Compost in BKM

Following private sector companies are selling compost in Bhaktapur.

Retailer: Shree Chuma Ganesh Agro Center, Byasi, 15.

Organic Fertilizer products by Navaratna Multi purpose Firm Pvt. Ltd., Urlabari – 6, Morang. – 400 kg per year (2kg = 25Rs). Tel: 021-540425. E mail: kedar @ wlink. com.np

Retailer: Bhaktapur Biz Bhandar, Suryabinyak .

Manoj International Traders Birgunj – 200 kg. Per year (1kg = 10Rs)
Tel: 051-25556,29893 , Kathmandu--4225124

Bokasi Fertilizer –

National Bokasi Center, Lalitpur (Organic matter 33.4%,N-1.6%,P-0.38%,K- 0.7%,with beneficiary bacteria , 450 kg per year,1 Kg = Rs 20 I-)

Mainly market compost is used by farmers at time of planting seedlings to grow good new plant at faster rate. Bokasi fertilizer is used in combination with home-made compost.

CHAPTER 3 PHASE II: RESULT OF EXISTING COMPOSTING FACILITY

3.1 Material Balance

3.1.1 General Material Balance at the BCF

Material balance is the total percentage by weight of the incoming waste converted into compost, recovered as recyclable and dumped as rejected material.

A 14 days material balance study was carried out between March 17, 2005 to March 30, 2005. The detail of material balance is presented in following Table 3.1-1. Graphical representation of the material balance scenario obtained during the 14 days are presented in following Figure3.1-1 to Figure 3.1-6 in the following pages.

It should be noted that the percentage of screened waste and their composition with regard to compost product, recyclable materials and rejected materials can be represented from the value obtained from the survey. However, the incoming of waste is not representative of the BCF practice, as during the dry season the waste is not brought to the facility. Only turning and screening of old windrows from wet season waste is carried out during the period.

3.1.2 Material Balance of Windrows Prepared Under the Survey

Material balance of the two windrows prepared under the Study was also studied for complete composting period of 57 days. Flow Chart representation of the material balance process and value of the surveyed windrow 1 and windrow 2 are presented in Table 3.1-2 and Table 3.1-3 respectively, and Figure 3.1-7. The data is presented in graphical format in Figure 3.1-8 and Figure 3.1-9.

Table 3.1-1 Daily Monitoring Record for Fourteen Days at Bhaktapur Composting Site

Date	Weather	Temp ^{0}C		Wi kg	Final Screening of Windrow (kg)			Wf kg	Wc kg	Remarks
		min	max		Ws	Wr	Wrj			
17/03	Cloudy			4,460		45.75	138.6		1,440	Old windrow turned
18/03	Cloudy			1,259			138.6			Old windrow turned
19/03	Sunny	13.5	26.2	1,590		75	1,062.6		720	Old windrow turned
20/03	Sunny	11.5	27.2	1,125			1,293.6			Old windrow turned, 8 trips tipper send to dumping site(1 full volume tipper carries 3640 kg of waste)
21/03	Sunny	10.5	27.6				739.2		720	Old windrow turned, 8 trips tipper send to dumping site(1 full volume tipper carries 3640 kg of waste)
22/03	Rained	12.4	22.6	445		71.45	1,247.4		720	Old windrow turned
23/03	Sunny	7.9	26.5	1,080		58.2	1,755.6			Old windrow turned
24/03	Sunny			874			1,478.4			Old windrow turned
25/03	Sunny			940		72.75	1,709.4			Old windrow turned, 8 trips tipper send to dumping site(1 full volume tipper carries 3640 kg of waste)
26/03	Partly cloudy			900	2,450	70.8	3,340.4	1,050	700	Screening
27/03	Partly cloudy			520	2,800		2,601.2	1,400	700	Screening

Date	Weather	Temp ^{0}C		Wi kg	Final Screening of Windrow (kg)			Wf kg	Wc kg	Remarks
		min	max		Ws	Wr	Wrj			
28/03	Sunny	10	27	620	3,500		2,370.2	2,100	2,100	Screening; 6 trips tipper send to dumping site(1 full volume tipper carries 3640 kg of waste)
29/03	Sunny	8.6	26.8	560	2,800	86.25	2,093	1,400	700	Screening, 8 trips tipper send to dumping site(1 full volume tipper carries 3640 kg of waste)
30/03	Sunny				2,800	102.3	2,416.4	1,400		Screening, 4 trips tipper send to dumping site(1 full volume tipper carries 3640 kg of waste)

Note: Recyclable items are Plastic, Metal and Glass
Wi: Incoming Waste Weight
Wf: Weight of Final Compost Product
Wrj: Weight of Rejected waste
Ws: weight of Waste sent for Screening
Temp: Temperature in 0C
Wc: Weight of Compost Sold
Loc: Location
Wr: Weight of recyclable items

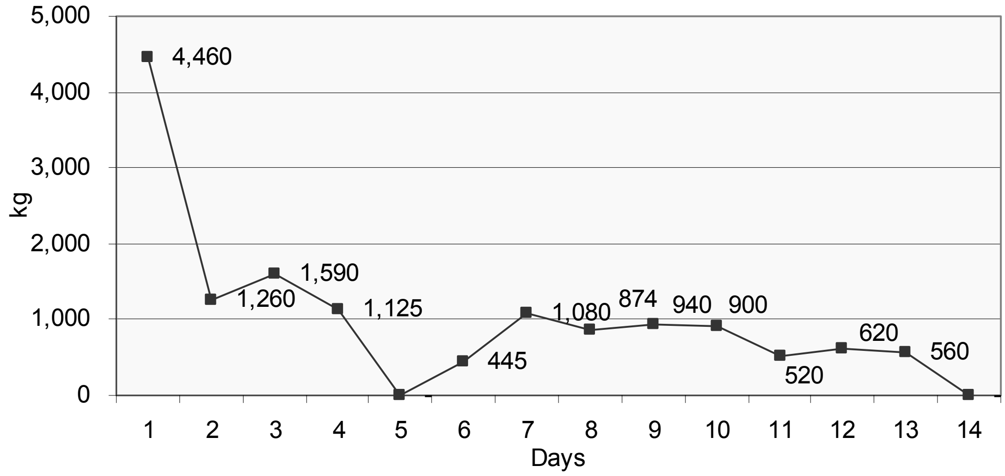


Figure 3.1-1 Incoming Waste at BCF: March 17 - 30, 2005

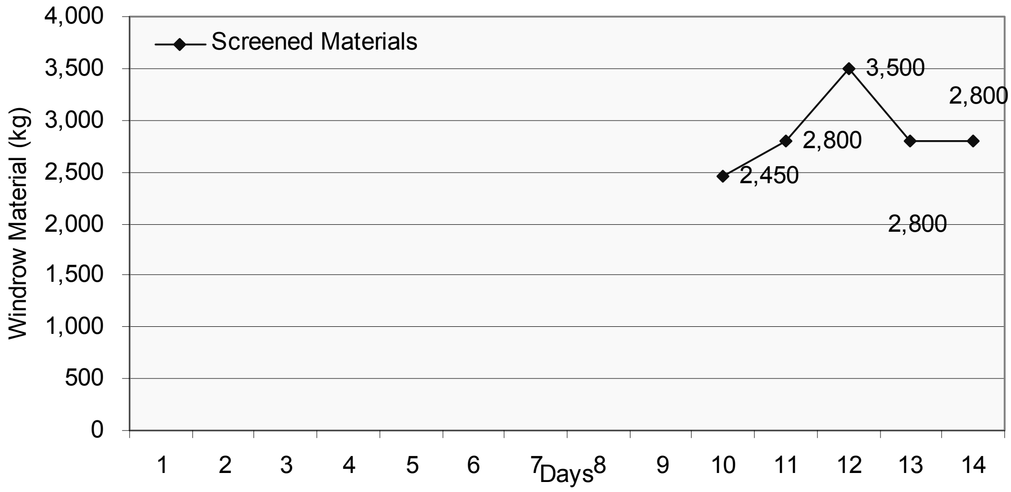


Figure 3.1-2 Compost Material Sent for Screening: March 17-30, 2005, BCP

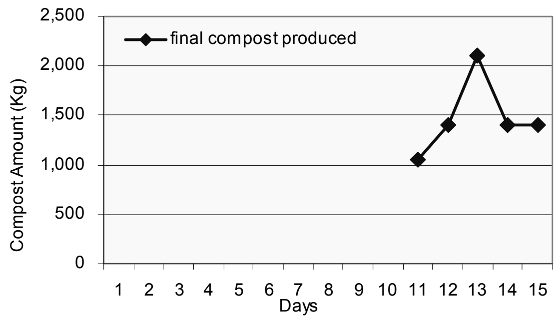


Figure 3.1-3 Amount of Compost Prepared at BCF, March 17-30, 2005

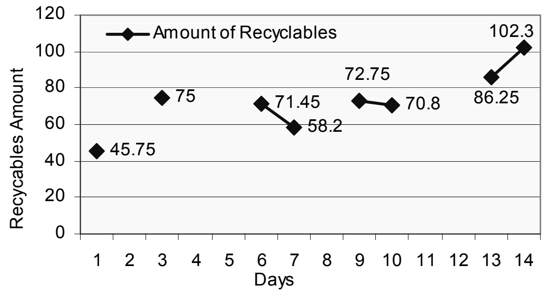


Figure 3.1-4 Recyclables Item from Turning and Screening of Windrows, March 17-30, 2005

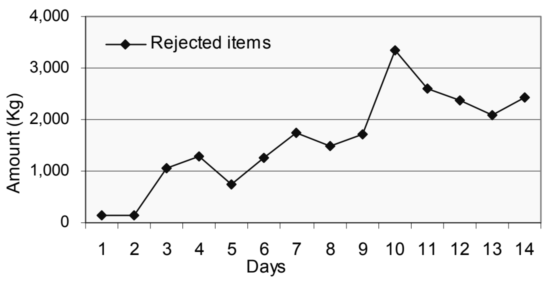


Figure 3.1-5 Rejected Items Collected from Windrows at BCF, March 17-30, 2005

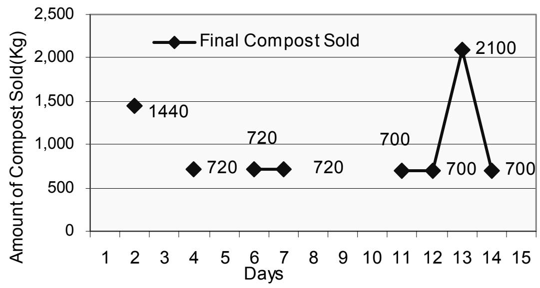


Figure 3.1-6 Trend in Compost Sold at BCF, March 17-30, 2005

Following Figure 3.1-7 presents the material balance of the windrow 1 and windrow 2 prepared during the JICA Study.

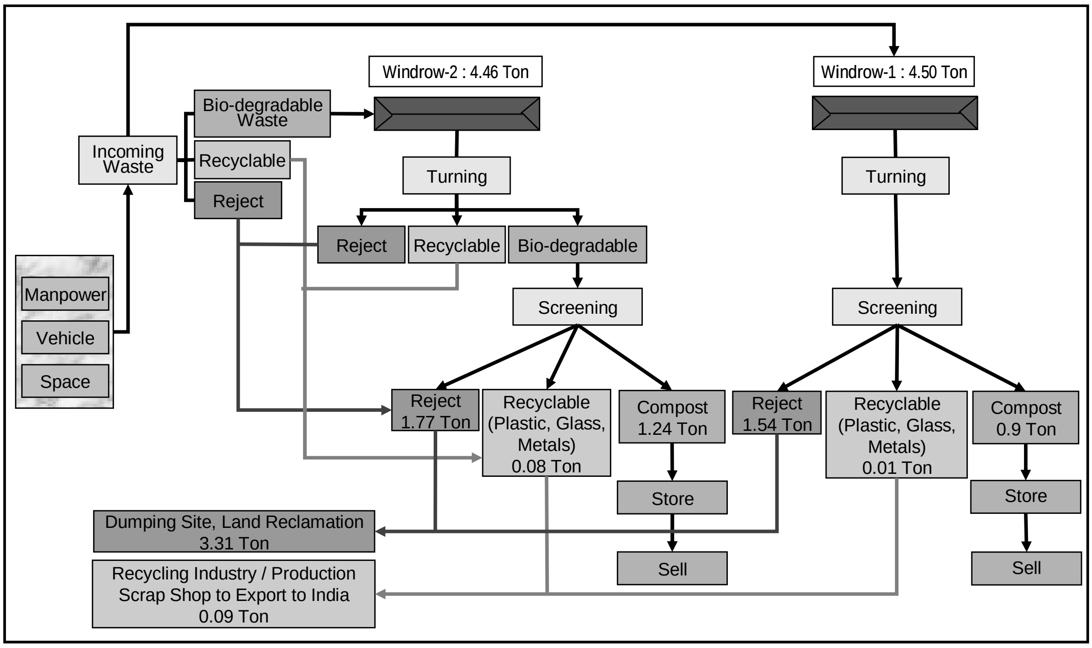


Figure 3.1-7 Flow Chart of Material Balance of Windrow 1 and Windrow 2 at BCF, 2005

Table 3.1-2 Material Balance of Windrow 1

Description	Weight in kg
Weight of Total Incoming Waste Before Composting	4,500
Weight of Windrow 1 Material	4,500
Balance Lost as Moisture	2,000
Final Compost	902.15
Recyclable	62.685
Rejected	1,537.35

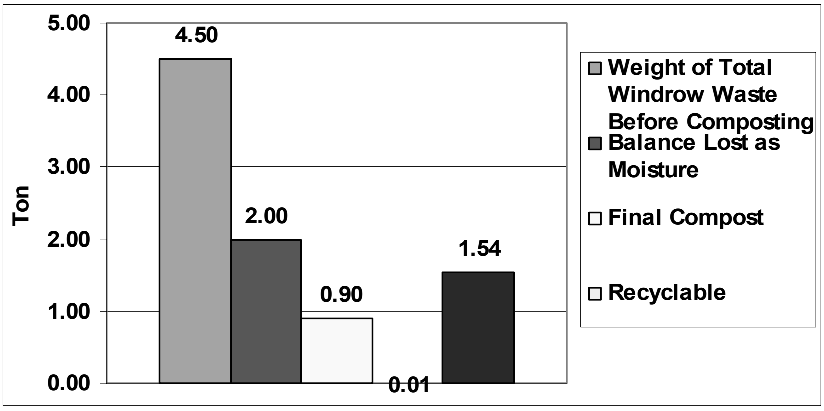


Figure 3.1-8 Material Balance in Window-1

Table 3.1-3: Material Balance of Windrow 2

Description	Weight in kg
Weight of Total Incoming Waste Before Composting	4,460
Weight of Material at Windrow 2	3,638
Balance Lost as Moisture	1,369.7
Final Compost	1,240.8
Recyclable	79.25
Rejected	1,770.25

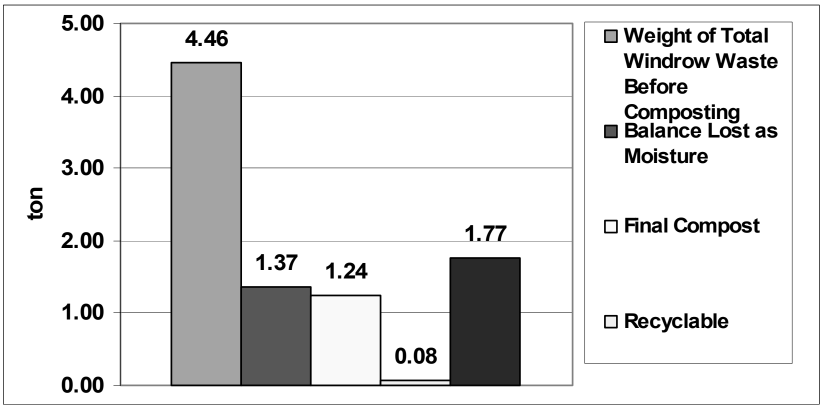


Figure 3.1-9 Material Balance in Window-2

3.2 Labor Record

There are total 14 labors and 1 guard working at Bhaktapur Compost Plant. Drivers of vehicles transporting waste to BCF are common for total waste collection and transportation fleet of the BKM. The age of the labors working at BCF are as presented in following Figure 3.10. The labors segregate incoming waste and recover recyclables, arrange waste in windrow, turn waste and sprinkle water, screen waste, recover recyclable during screening, dump rejected materials at the designated corner, and stock compost. Responsibility of Guard is to stay at compost site day and night.

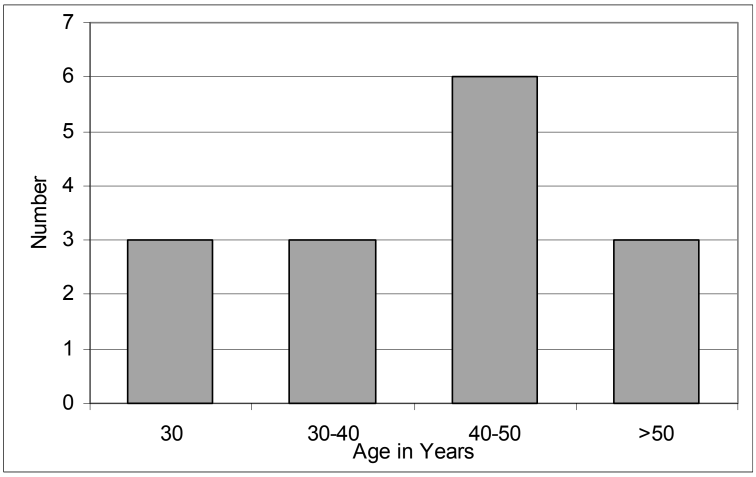


Figure 3.2-1 Labors Working at BCF

From the Figure 3.10 above, it is obvious that the majority of labor force working at BCF is in the age of 40 – 50. There are also labors of age more than 50. However, as the work at BCF is labor intensive, effort should be made to keep younger work force, which are strong and can work for longer duration.

3.2.1 Study of a Complete Cycle of Compost Preparation

The process adopted by the Study Team to survey a complete cycle of compost preparation has been presented in Sub-section 1.4 in Chapter 1.

Two windrows were prepared. Windrow 1 was prepared from the municipal waste without segregation and recovery of recyclable and rejects material, in the condition it arrived at the BCF. Windrow 2 was prepared after segregation and recovery of recyclable and rejects material from the mixed state of municipal waste after it arrived at BCF. One and half day was spent to segregate materials from 4.46 ton of waste. Almost 6 labors were used to segregate the waste. Weight of all form of waste (incoming mixed waste, recyclable waste recovered and rejected waste) was recorded to find out percentage by weight.

The JICAStudy Team availed a state of art digital infrared moisture content measuring equipment to analyse bulk density automatically. Similarly temperature measuring equipment was also provided. Mr. Moti Bhakta Shrestha of BKM actively participated in managing and recording data, as needed in cooperation with the expert from SILT Consultant.

Each windrow was monitored in terms of windrow temperature, moisture content, bulk density, water added, EM Solution added and atmospheric temperature and humidity. Monitoring was done for fist seven continuous days and then once in five days till the compost was prepared (total 57 days). Weather Record (atmospheric temperature and humidity) was collected throughout the windrow monitoring days from the Hydro-meteorological Station at Tribhuvan International Airport, Kathmandu.

Temperatures of windrow were taken each sampling day from 5 different locations at the core of the windrow, and the mean was then calculated.

For first six consecutive days for windrow I and five days for windrow II; some amount of sample were taken in a plastic container and left for sundry till last two consecutive weights were constant. Moisture Content (MC) in percentage was calculated using following formula:

MC(%) = (wt before drying-wt after drying)*100/wt before drying.

For other days moisture content was measured with help of Infrared Instrument provided by JICA. Sample for moisture content were taken from 5 same point in a windrow used to measure temperature.

For calculating bulk density some waste were taken in a laboratory beaker of known volume. The weight of waste was measured with help of spring balance. The volume was estimated if in case the container was not full with waste; such as 80 % of 4.7 liter, 70 % of 4.7 liter etc. Bulk density (BD) was then calculated using following formula:

BD(gm/ltr) = weight of waste(gm)/volume of container(liter)

Wet bulk density and dry bulk density were calculated before and after drying of the sample. Amount of waster added to windrow was also taken. This was done by calculating the flow of water in terms of liter per second and total time required for watering the windrow. Time was measured with help of stopwatch. Throughout the process EM solution was not added.

Following sub-sections presents the data recorded during the above mentioned exercise and their analysis for various parameters.

3.2.2 Findings from Windrow 1

The incoming waste was at first stored in a conical heap after thoroughly mixing by spade. It was then divided in four equal parts. The opposite parts were discarded and remaining two parts were again mixed and formed in conical heap. It was again divided in four equal parts. Two opposite parts were rejected and two parts again mixed and heaped. The process was continued till a representative sample of 5 to 8 kg waste remained. The sample was weighed and volume measured. Bulk Density was then calculated. It was then separated into 10 items: paper, garbage, textile, wood, plastic, rubber & leather, metal, glass, ceramics and others. Percentage weight of each item was then calculated. Moisture content percentage of each item was also measured with help of Infrared instrument. Such sampling was done twice.

After sampling the remaining waste was piled up to make a windrow and left for composting. The process was carried out on March 16, 2005. The windrow was named as windrow I. The findings with average values in Windrow 1 are presented hereunder.

(1) Waste Characteristics Before Composting

Following Figure 3.2-2 presents the categorization of waste.

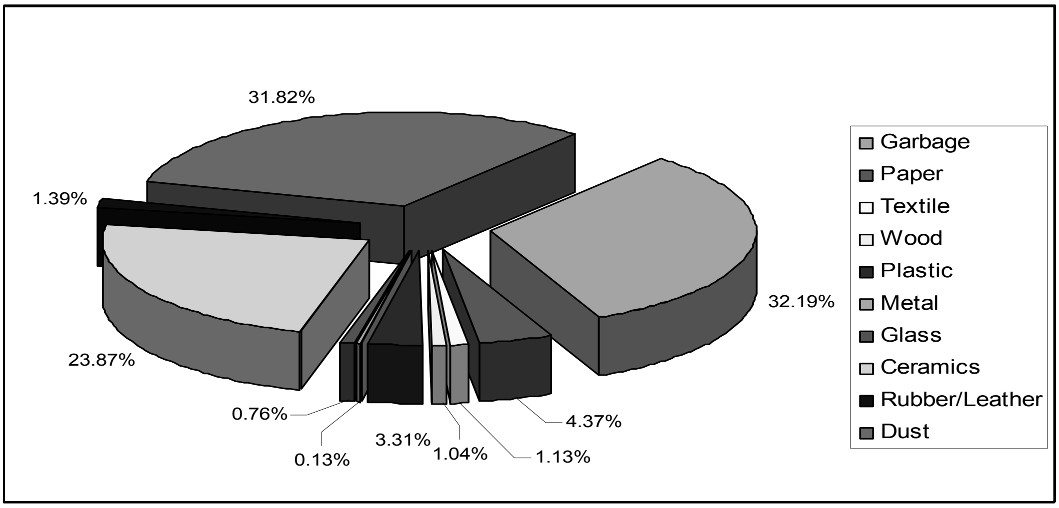


Figure 3.2-2 Categorization of Waste Before Composting

Above figure Figure 3.2-2. shows the characterization of waste brought to compost plant for composting. The pie- chart shows that the highest percentage is of garbage (31.29%), followed by dust (31.82%) and of ceramics (23.87 %). ceramics mainly contained pieces of clay pots, sometimes bricks. Bhaktapur is famous for its clay pottery. Thus, its percentage is naturally high. As the waste is collected from street side, percentage of dust is high representing characteristic of street waste, which is mixed with household waste. Metal was least present in the sample (0.13%).

Following graph Figure 3.12 shows the categorization of waste after completion of composting process. The composition is highest for the compost produced (55.16%), which is followed by ceramics (21.45%) and then by rejected materials (12.33 %). The least composition is that of rubber/leather (0.07%)

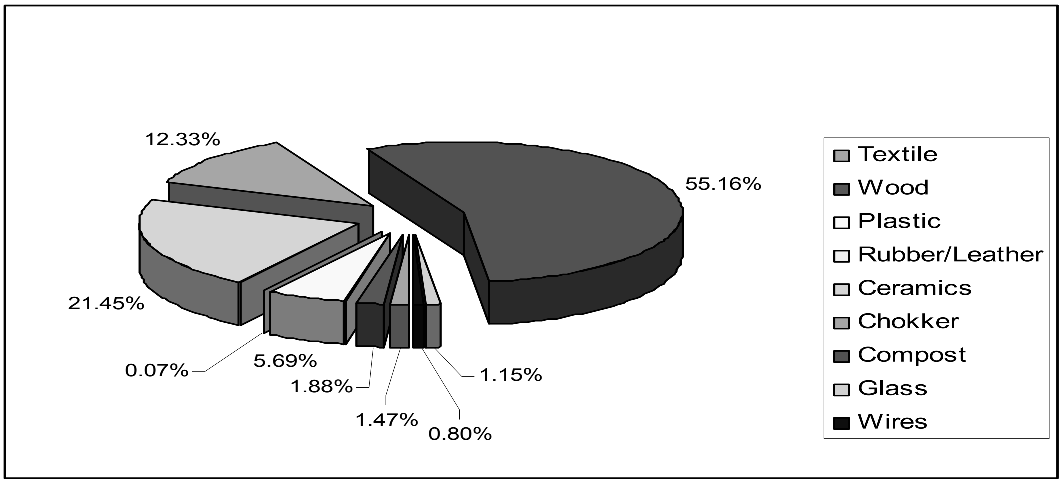


Figure 3.2-3 Categorization of Waste after Composting

(2) Temperature of Windrow

Following Figure 3.2-4 presents the trend in temperature change in Windrow 1 during sampling days during its complete composting cycle of 57 days. Windrow 1 was turned on

27th, 35th, 45th and 55th day of the sampling. Average temperature content increased for first few days and then decreased, again increased to 65.86 oC after the first turning was made then to 68.78 oC. the compost temperature then gradually decreased with degradation of the waste.

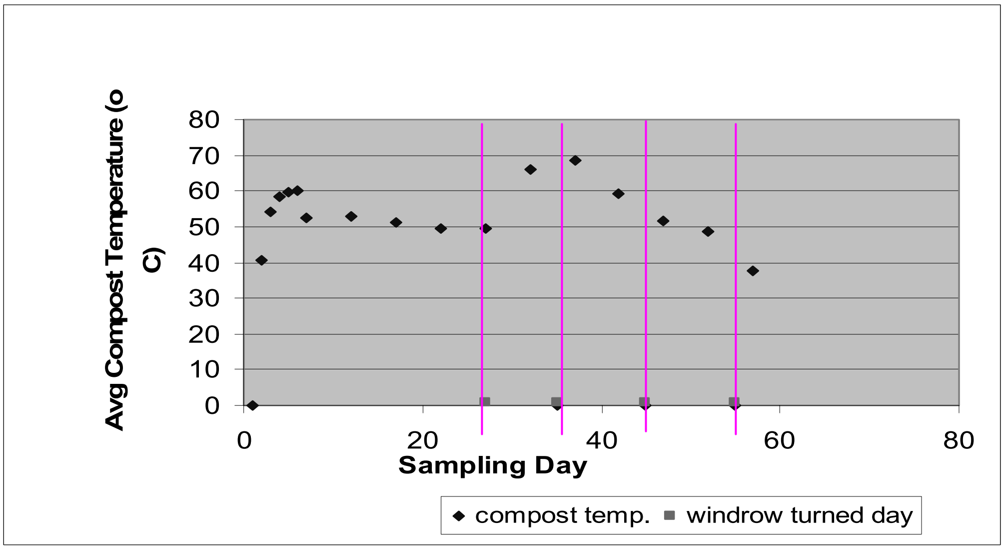


Figure 3.2-4 Change in Temperature of Windrow 1 and Turning of Windrow

Following graph presented in Figure 3.2-5 show plot of average temperature of windrow 1 in degree centigrade Vs atmospheric minimum and maximum atmospheric temperature during the sampling days.

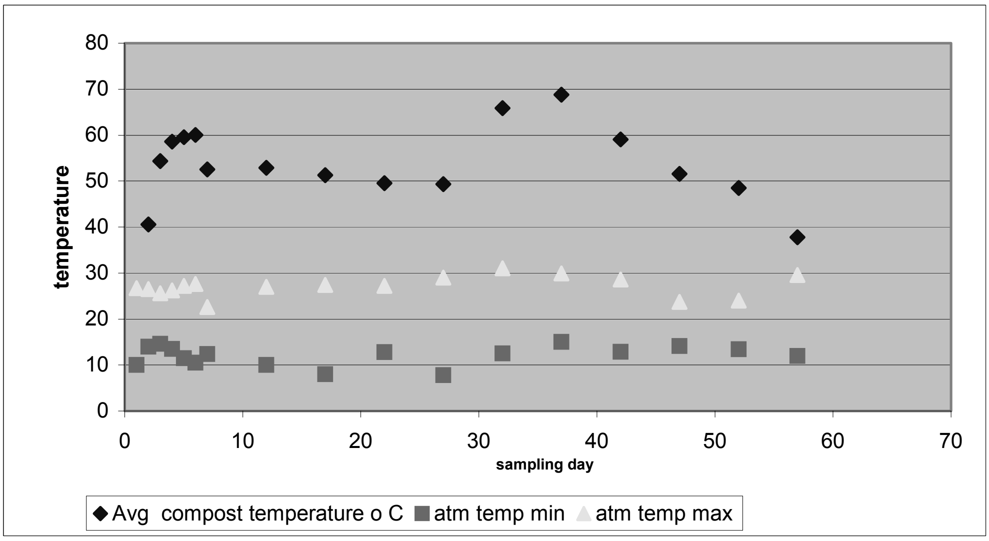


Figure 3.2-5 Comparative Chart of Change in Atmospheric and Windrow Temperature

(3) Moisture Content

Following Figure 3.2-6 presents the moisture content of Windrow 1 during its complete composting cycle of 57 days. From the graph, estimation can be made that the percentage moisture content of the windrow decreased with sampling days. Error in parameter reading for 3rd, 4th and 5th day might be due to the presence of materials having low water content like plastics, hay, mud etc.

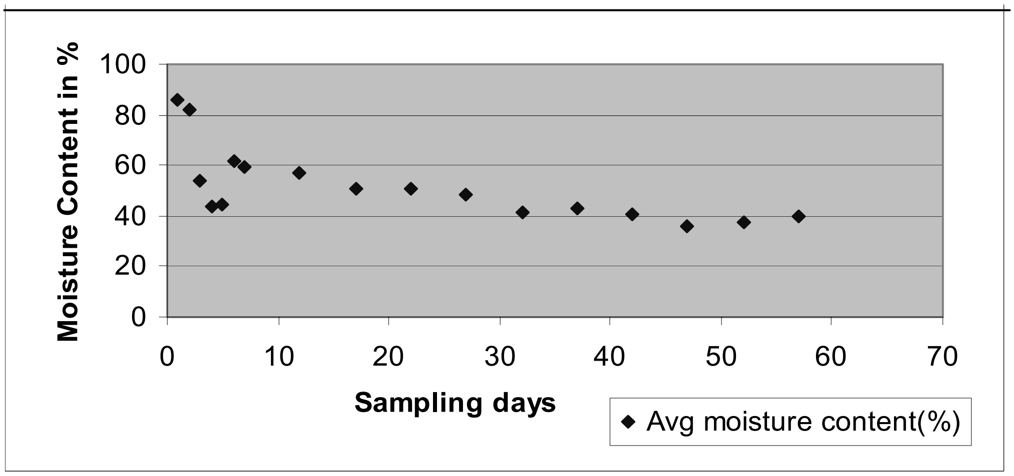


Figure 3.2-6 Change in Moisture Content of Windrow 1

Fluctuation observed in atmospheric humidity measured at 8:45 am and 5:45 pm Nepal Standard Time (NST) during the sampling days are presented in following Figure 3.2-7.

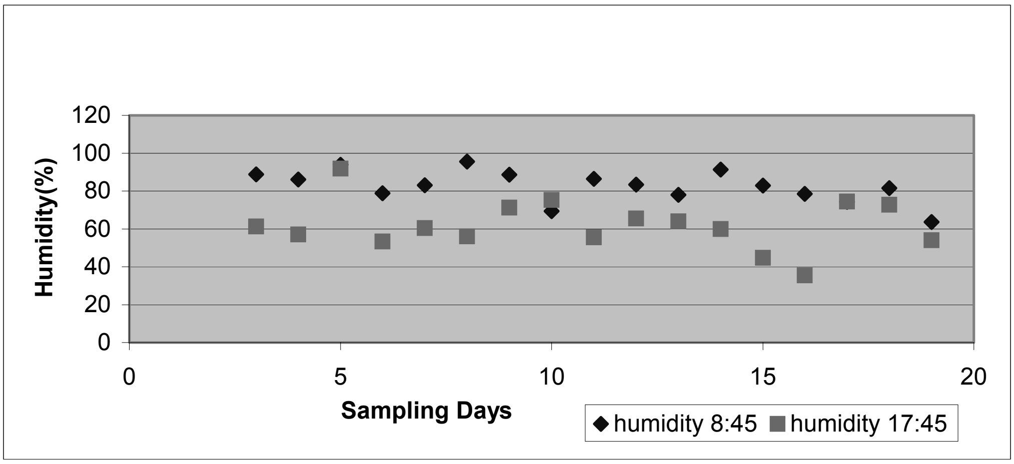


Figure 3.2-7 Change in Atmospheric Humidity Measured at 8:45 AM and 5:45 PM During the Sampling Days for Windrow 1

(4) Bulk Density of Windrow

The following graph in Figure 3.2-8 shows the trend in change in density of windrow 1. From the graph, estimation can be made that the bulk density increased as the degradation activity continued during the process of composting. This is because decrease in volume of compost due to loss of moisture content in the process.

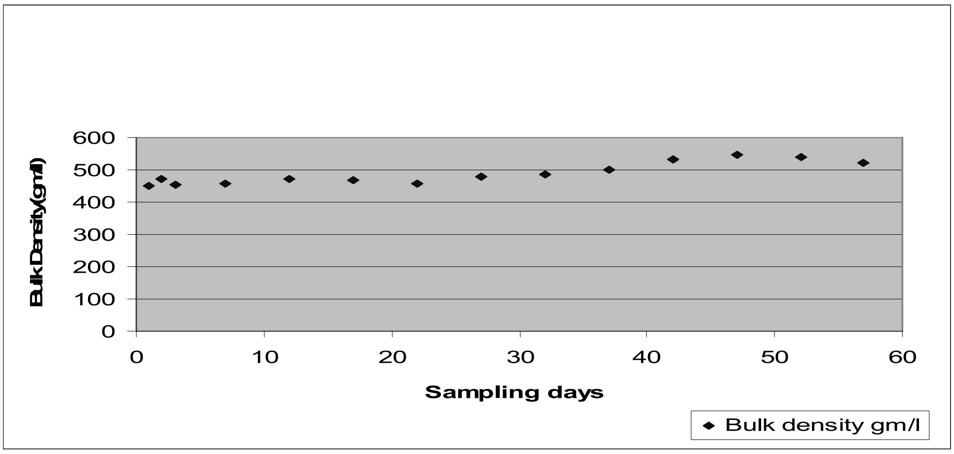


Figure 3.2-8 Change in Bulk Density during Process of Composting

(5) Addition of Water in Windrow 1

The graph presented in Figure 3.2-9 shows the amount of water added to windrow 1 during the monitoring days. Rainfall received days is also shown by the graph. Water was added only after reading the parameters: temperature, moisture content (%) of the samples to measure density. Addition of water is necessary to keep the temperature of windrow under control.

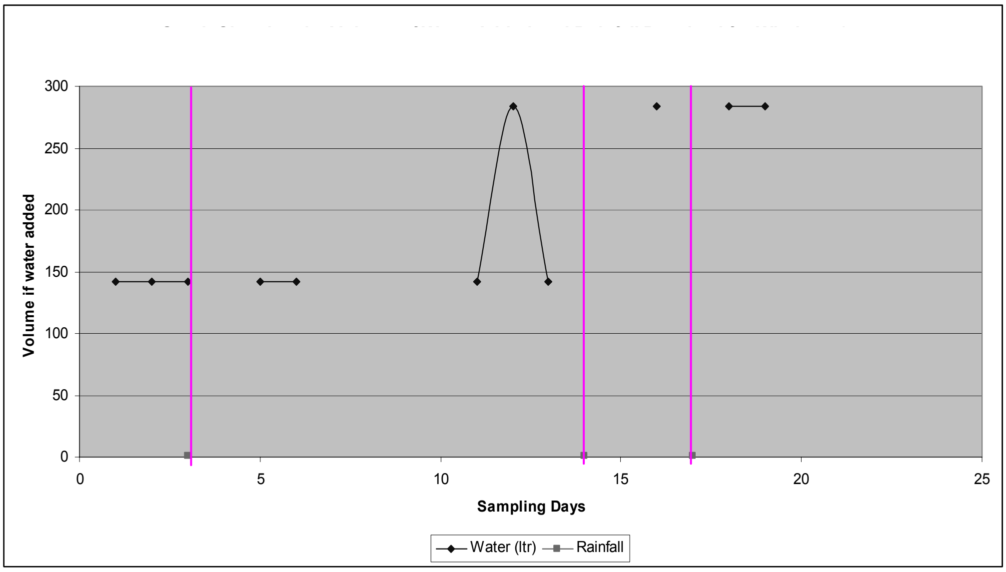


Figure 3.2-9 Addition of Water in Windrow 1 During Process of Composting (in ltr.)

3.2.3 Findings from Windrow 2

The incoming waste of March 17, 2005 was at first sorted to separate all foreign matters including recyclables and reject material for one and half day. Then, the segregated waste was stored in a conical heap after thoroughly mixing by spade. It was then divided in four equal parts. The opposite parts were discarded and remaining two parts were again mixed and formed in conical heap. It was again divided in four equal parts. Two opposite parts were rejected and two parts again mixed and heaped. The process was continued till a representative sample of 5 to 8 kg waste remained. The sample was weighed and volume measured. Bulk Density was then calculated. It was then separated into 10 items: paper, garbage, textile, wood, plastic, rubber & leather, metal, glass, ceramics and others. Percentage weight of each item was then calculated. Moisture content percentage of each item was also measured with help of Infrared instrument. Such sampling was done twice.

After sampling the remaining waste was piled up to make a windrow and left for composting. The windrow was named as windrow I. The findings with average values in Windrow 1 are presented hereunder.

(1) Waste Characteristics Before Composting

Following Figure 3.2-10 presents the categorization of waste.

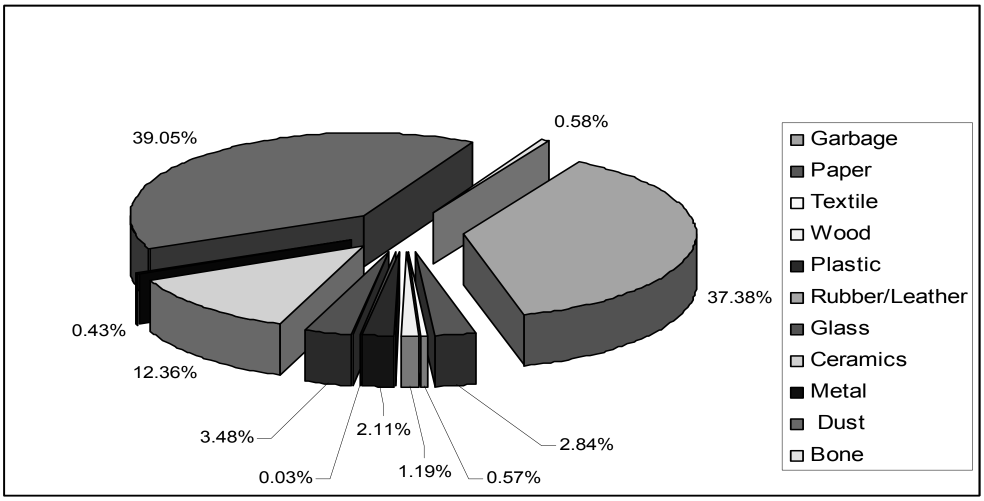


Figure 3.2-10 Categorization of Waste After Sorting of Windrow 2

Above Figure 3.2-10 presents the characterization of waste brought to compost plant for composting. The waste brought was segregated into recyclables, rejects and material suitable for composting. Only the third category was piled to make windrow. The pie- chart shows that the highest percentage is of dust (39.05%), followed by garbage (37.38%) and of ceramics (12.36 %). Ceramics mainly contained pieces of clay pots, sometimes bricks. Rubber /leather was least present in the sample (0.03%). Percentage of dust is higher due to the waste collected was from street and not door-to-door collection.

Following graph presented in Figure 3.2-11 shows the categorization of composting remains. The composition is highest for the compost produced (71.99%), which is followed by ceramics (12.81%) and then by chokker (8.74 %).

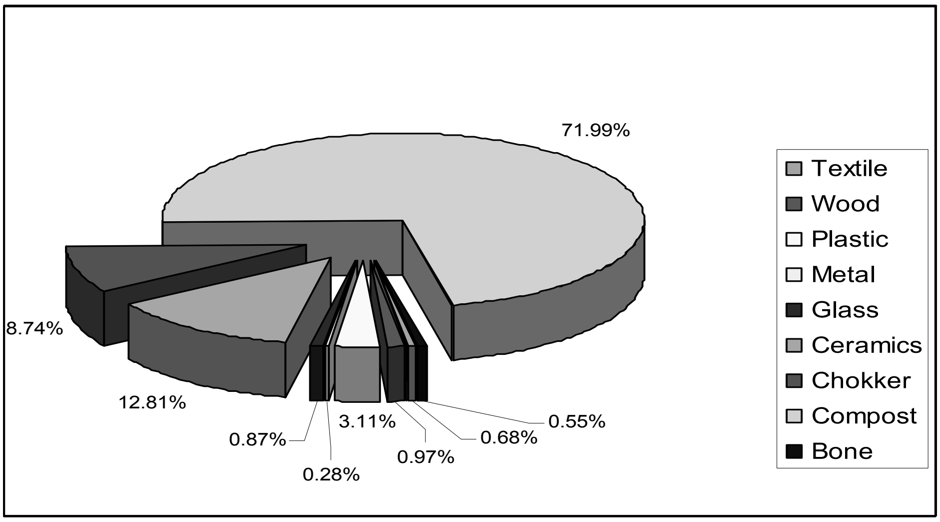


Figure 3.2-11 Categorization of Waste after Composting in Windrow 2

Comparing Figure 3.2-2/3.2-3 and Figure 3.2-10/ 3.2-11, it can be observed that percentage of compost produced is higher for the latter case than former, i.e. with segregation then without segregation. However this data cannot be generalized due to less number of sample were taken.

(2) Temperature of Windrow

Following Figure 3.2-12 presents the trend in temperature change in Windrow 2 during sampling days during its complete composting cycle of 57 days. Windrow 2 was turned on 27th, 34th, 44th and 54th day of the sampling. Average temperature content increased for first few days and then decreased; again increased again to 69.29 °C after the first turning was made then gradually decreased with degradation of the waste.

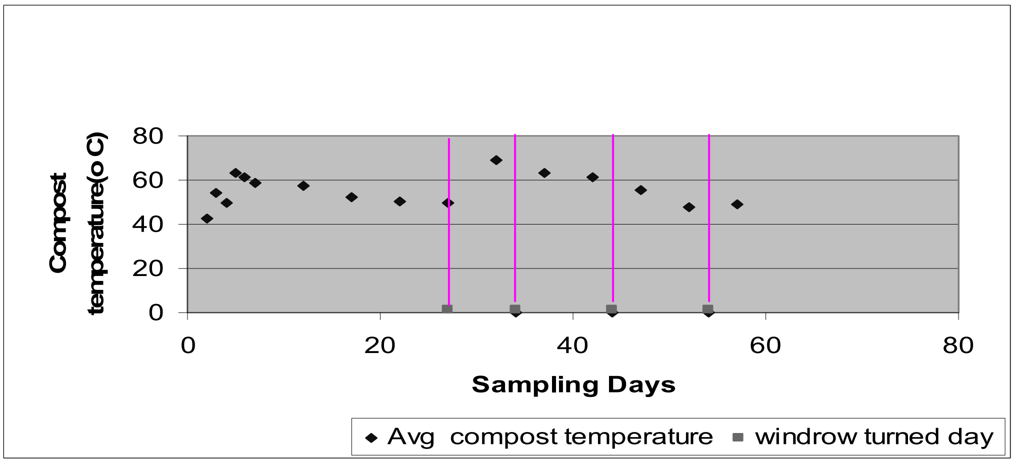


Figure 3.2-12 Change in Temperature of Windrow 2

Following graph presented in Figure 3.2-13 show plot of average temperature of windrow 2 in degree centigrade Vs atmospheric minimum and maximum atmospheric temperature during the sampling days.

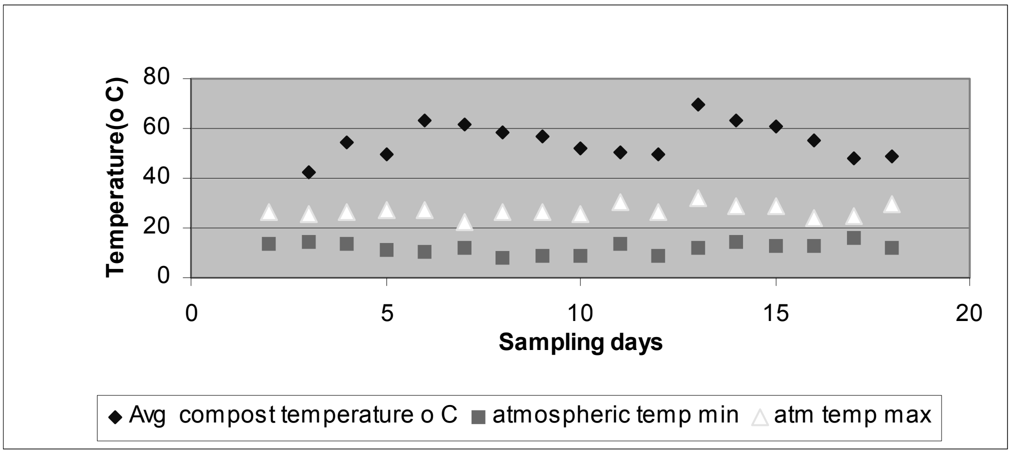


Figure 3.2-13 Comparative Chart of Change in Atmospheric and Windrow Temperature

(3) Moisture Content

Following Figure 3.2-14 presents the moisture content of Windrow 2 during its complete composting cycle of 57 days. From the graph, estimation can be made that the percentage moisture content of the windrow decreased with sampling days. Error in parameter reading for 3rd, 4th and 5th day might be due to the presence of materials having low water content like plastics, hay, mud etc.

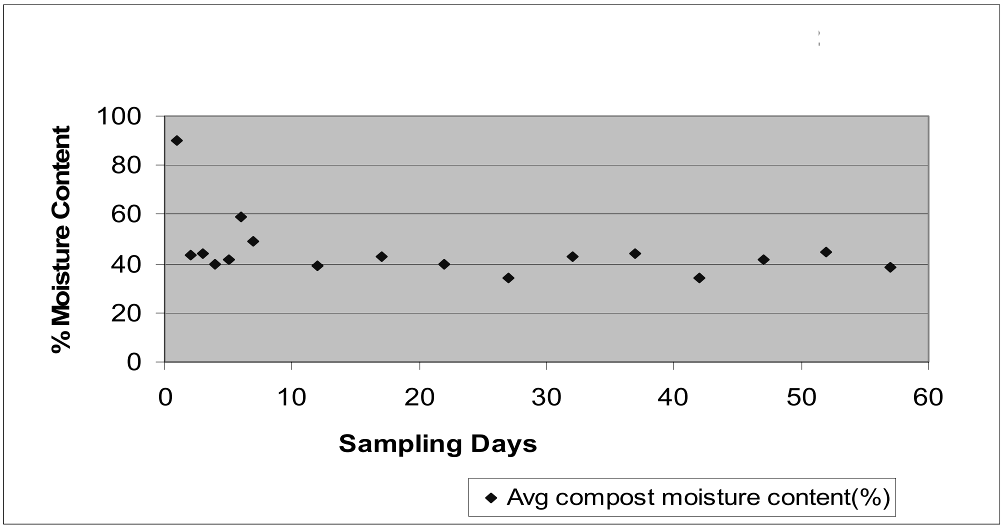


Figure 3.2-14 Change in Average Moisture Content (%) in Windrow 2

Fluctuation observed in atmospheric humidity measured at 8:45 am and 5:45 pm Nepal Standard Time (NST) during the sampling days are presented in following Figure 3.2-15.

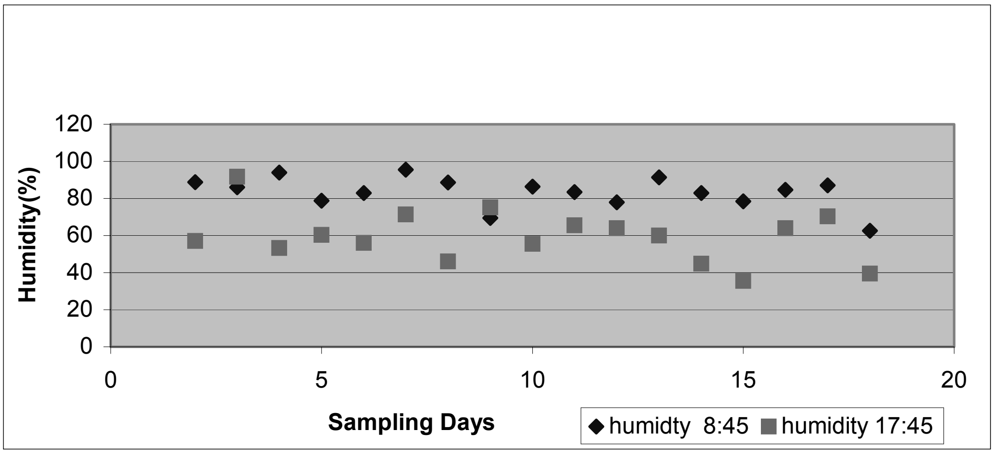
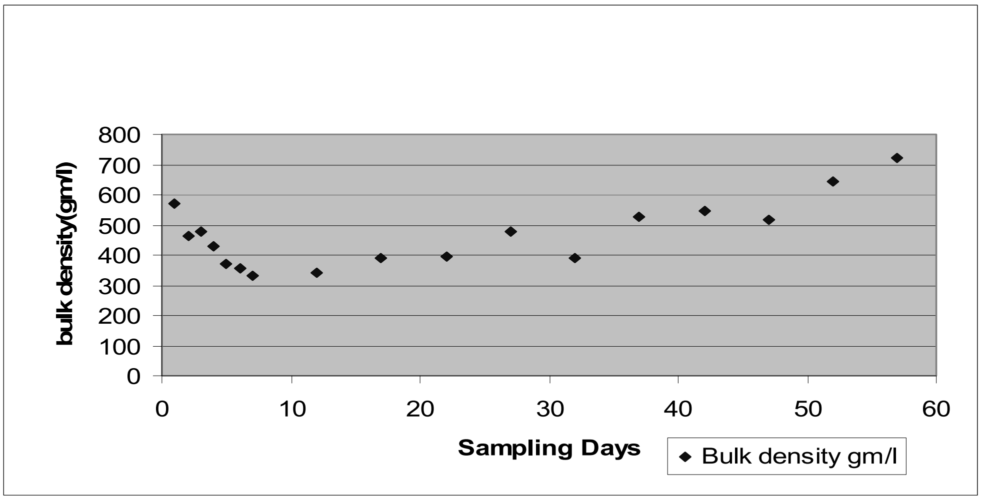


Figure 3.2-15 Change in Atmospheric Humidity

(4) Bulk Density of Windrow

The following graph in Figure 3.2-16 shows the trend in change in density of windrow 2. From the graph, estimation can be made that the bulk density increased as the degradation activity continued during the process of composting. This is because decrease in volume of compost due to loss of moisture content in the process. Further, fluctuation is more in the case of windrow 2 than in windrow 1. the initial phase of less bulk density may be because of larger volume of waste sample due to presence of straw, hay and similar lighter material with larger volume, thus reducing bulk density.



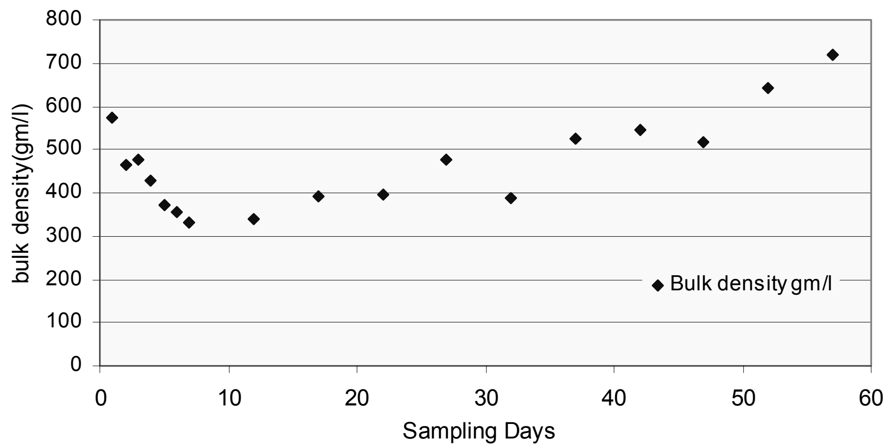


Figure 3.2-16 Change in Bulk Density (gm/ltr.) During Process of Composting in Windrow 2

(5) Addition of Water in Windrow 2

The graph presented in Figure 3.2-17 shows the amount of water added to windrow 2 during the monitoring days. Rainfall received days is also shown by the graph. Water was added only after reading the parameters: temperature, moisture content (%) of the samples to measure density. Addition of water is necessary to keep the temperature of windrow under control.

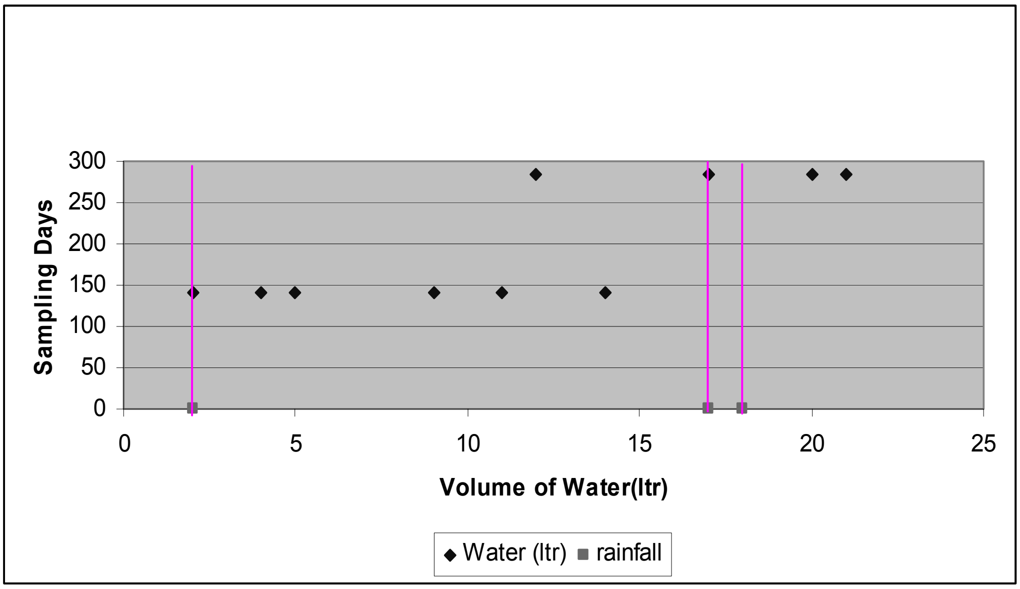


Figure 3.2-17 Addition of Water in Windrow 2 During Process of Composting (in ltr.)

3.3 Compost Quality of Windrow 1 and Windrow 2

The quality of compost prepared in windrow 1 and windrow 2 are as presented hereunder in Table

Table 3.3-1 Quality of Compost

Compost Quality Analysis on Dry Weight Basis									
Compost sample	**pH.**	**Total N (%)**	**Total P (%)**	**Total K (%)**	**Org. Comp (%)**	**Moisture (%)**	**C/N ratio (%)**	**Elec. Cond. mS.cm^{-1}**	**Foreign particles (%)**
Windrow-1	7.9	0.80	0.23	3.36	8.33	3.09	11.04	0.825	2.64
Windrow-2	7.2	0.88	0.17	3.59	10.01	2.04	11.37	0.9	4.36

Analysis of compost quality presented in detail in Sub-section 4.4 in Chapter 4.

It should be noted here that the Moisture Content % is very low, because the sample could be tested only after couple of days of preparation, and that too after air drying for estimating in dry weight basis. Otherwise, as per past data and the Windrow study carried out by CKV, 2005, average moisture content of compost is in the range of 40 % for fresh compost.

3.4 Utility Consumption

Cost of electricity for the FY 2060/2061 B.S/2003-2004 A.D is presented in the following table. Throughout the year the cost/consumption is high during the month of Falgun (Feb-March) which was Rs 3150 and the least being in the month of Magh (Jan-Feb), which was Rs 813. Similarly charge for water was Rs 1,129 for the same FY. It is shown in Table 3.4-1.

Table 3.4-1 Detail of Electricity Bill At BCF in FY 2060/61
(Shrawan, 2060 - Ashadh, 2061)

Year	Month	Month (AD)	Amount (Rs)	Remark
2060	Shrawan	July-August, 2003	1475	
2060	Bhadra	August-September, 2003	1572	
2060	Ashoj	September-October, 2003	1383	
2060	Kartik	October-November, 2003	1473	
2060	Mangsir	November-December, 2003	1630	
2060	Poush	December-January, 2004	1919	
2060	Magh	January-February, 2004	813	
2060	Falgun	February-March, 2004	3150	
2060	Chaitra	March-April, 2004	1218	
2061	Baishakh	April-May 2004	1226	
2061	Jestha	May-June 2004	1317	
2061	Ashadh	June –July 2004	1077	
Total Expenditure in Rs in FY 2060/61 (2003-2004)			18252	

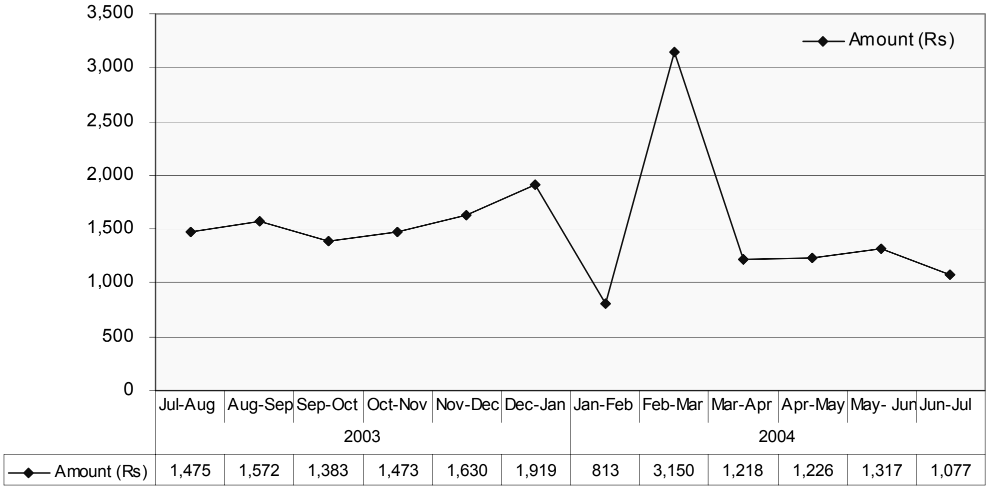


Figure 3.4-1 Electricity Bill at BCF for the FY2003/04

Table 3.4-2 Material Balance and Cost Scenario of BCF For FY2003/04

S. No.	Item	Amount (in Ton)	Expenditure Rs	Income Rs
1.	Incoming of Waste	1752		
2.	Compost Production	267		
3.	Recyclable (plastics)	0.7		
4.	Reject	995		
5.	Fuel Cost		255,617	
6.	Human Resource		52,500	
7.	Electricity Cost		18,252	
8.	Water Supply Cost		1,129	
9.	Sell of Compost			38,950
TOTAL			327,498	38,950
BALANCE				(-288,548)

It should be noted that BKM does not have record of fuel cost and vehicle maintenance cost separately for the BCF. Total expenditure in fuel in the year 2003-2004 is Rs 793,250, and for vehicle maintenance is 373,003. Thus, total expenditure becomes Rs 1,166,253. Total waste taken in the BCF in year 2003-2004 is 1,752 ton, where as total yearly waste production in BCF is 7,993 ton at the rate of 21.9 ton per day (CKV Study, 2004/05). Thus, total waste taken to the BCF is 21.9 % of the total waste. If the same percentage is considered for estimating expenditure in fuel and vehicle maintenance, total yearly expenditure will be Rs 255,617.

From the above Table 3.4-2, it is evident that production of compost is not sustainable at the BCF. One of the reason for this is due to the objective of Bhaktapur Municipality to use the BCF is not to produce compost, but to use it as a waste dumping site during wet season when vehicle cannot dump waste beside river banks due to access problem.

CHAPTER 4 COMPOST EFFICIENCY TEST

4.1 Background

Soil consist of a wide range of organic substances including living organisms, carbonaceous remains of organisms that once occupied the soil, and organic compounds produced by current and past metabolism in the soil. The remains of plants, animals, and microorganisms are continuously broken down in the soil and other microorganisms synthesize new substances. Over time, organic matter is lost from the soil as carbon dioxide produced by microbial respiration. Because of such loss, repeated additions of new plant as well as animal residues or other organic manure e.g. compost are necessary to maintain organic composition of soil. Under conditions that favor plant production more than microbial decay, large quantities of atmospheric carbon dioxide used by plants in photosynthesis are sequestered (acquired) in the abundant plant tissues, which eventually become part of the soil organic matter.

Organic matter binds mineral particles into a granular soil structure that is largely responsible for loose, easily managed condition of productive soils. Part of the soil organic matter that is especially effective in stabilizing these granules consist of certain glue-like substances produced by various soil organisms, including plant roots.

Organic matter also increases the amount of water a soil can hold and the proportion of water available for plant growth. In addition, it is a major source of phosphorus and sulfur, and the primary source of nitrogen necessary as plant nutrients. As soil organic matter decays, these nutrient elements, which are present in organic combinations, are released as soluble ions that can be taken up by plant roots. Finally, organic matter, including plant and animal residues, is the main food that supplies carbon and energy to soil organism. Without it, biochemical activity, which is so essential for functioning of ecosystem, would come to a near standstill.

Organic manures of plant nutrients comprise several sources such as compost, farmyard manure, green manure and crop residue etc. At present context, one of the major source of compost is either manure made of animal dung and chicken droppings or the compost made from municipal solid waste.

4.1.1 Review of Literature

A 5 year National Research Project on “Improvement of Composting Process of Municipal Refuse and Agricultural Use of the Product” was carried out from 1976 to 1980 in Japan. This compressive study evaluated the characteristics of municipal refuse compost from the agricultural standpoint as follows:

- **Appearance and Undesirable Contaminations**

Moisture content of the composts treated in various composters for 2-10 days was 50-60%. Screening as a final processing resulted in the desired uniformity in size for handling and increased the eye appeal of the final product. However, the product contained undesirable contaminants such as tiny bits of glass ceramic, metal, plastic, etc. depending upon the composting systems used and the quality of collected refuse. Generally, the content of undesirable contaminants is considered less than 3% on an oven dry basis. Glass bits not only pose a visual problem but also are a handicap in crop production. Municipal refuse compost has not been recommended for application to paddy fields because of contamination with glass. Heavy metal contamination is also a problem in the compost plant.

- **Nutrient Content**

Nutrient content in municipal refuse compost are presented in Table 4.1-1, which shows wide variation in chemical composition. Compared with crop residue compost, municipal refuse compost is roughly equal in N content, higher in P, and lower in K. Municipal refuse compost generally has high ca content and a higher CaO-MgO ration than crop residue compost.

The nutrient content of municipal refuse compost generally increased with of composting and maturation, but its N content did not always increase (Watanabe and Kurihara, 1982). Ammonia volatilization was observed under high pH and relatively low moisture conditions during the maturation period.

- **Organic Composition**

Inoko et al. (1979) analyzed the organic composition of municipal refuse composts produced in Japan from the standpoint of their suitability for application to land. Their results indicated that the C-N ratio ranged from 19 to 31. There is much evidence that composted materials having a C-N ratios less than 20 cause no N starvation when applied to the soil. Consequently, most of the samples taken from mechanical digesters (retention time: less than 10 days) are immature. Total C, C-N ratio, cellulose, hemicelluloses, and the ratio of reducing sugar c to total C decreased during the 5 week maturation period; after that period their content did not change while total N, lignin, and ash content slightly increased and then maintained a constant value (Harada et al. 1981). The decreasing rate of cellulose and the ratio of reducing sugar C to total C were much larger.

Table 4.1-1 Nutrient Contents of 21 Municipal Refuse Compost and 6 Crops Residues Composts. (Watanabe and Kurihara, 1982)

	Municipal Refuse Compost		Crop Residue Compost	
Element	Range (%)	Average (%)	Range (%)	Average (%)
N	1.24-3.47	1.95	0.96-2.30	1.50
P	0.21-1.57	0.55	0.2-0.38	0.24
K	0.45-2.60	1.19	1.18-3.25	2.37
Ca	2.30-6.74	4.17	0.52-1.94	1.21
Mg	0.11-1.69	0.34	0.15-0.53	0.35

Moreover, they indicated that the distribution of N in the acid, non-hydrolysable ammonium amide, hexamine amino acid and unidentified fractions was not significantly different among municipal refuse compost and did not change during the maturation process. It can be concluded from these results that the primary product prepared in the mechanical composters is not a sufficiently mature one for land application. Inoko et al. (1982) proposed a guide line for organic components of municipal refuse compost as follows: 1) a C-N ratio below 20, 2) total N content above 2 % and 3) the ratio of reducing sugar C to total C below 35 %.

- **Microorganisms**

Microbial population and composition vary very widely. The following range per gram dry weight was obtained bacteria (107-108), fungi (103-107), actinomycetes (104-107), coliform group, (102-104) (Tsuru, 1981). All microflora groups in the primary product decreased markedly within a few days after 600 C had been reached under conditions of aeration and turning and the composition of microflora was stabilized within 2 weeks. This finding suggests that maturation of the primary product is necessary for stabilization of the microbial population.

- **Nitrogen Mineralization and Immobilization**

If the C-N ratio of compost is too high (more than 20), there could be danger of N starvation in crops and abnormal reduction in soil (Parr, 1975). A soil incubation test is widely used to evaluation the N behavior in the soil when organic matter is applied. This test (Watanabe and Kurihara 1982) indicated that N immobilization was largely enhanced by the addition to the soil of immature compost with a high C-N ratio, whereas N released occurred in mature compost with a C-N ratio less than 20. The same authors further examined the N robbing effect of immature municipal refuse compost on wheat growth under green house conditions. There was a close relationship between N uptake and immobilization or mineralization (or both) of N obtained by the soil incubation test. Hence the decrease in yield and N uptake is possibly attributed to the N robbing effect. Although N starvation can be avoided by applying sufficient chemical N fertilizer to the soil to compensate for any deficiency, the final product should be sufficiently mature to prevent N starvation of crops.

4.1.2 Effect of Compost on Physical Properties of Soil

The physical properties of soil are affected in following ways:

- It pulverizes soil and improves soil structure
- It improves aeration in heavy soils and increase particle binding properties in sandy soils.
- It produces organic acids, which neutralize salt, and thereby buffers soil reaction.
- It improves water-holding capacity of soil.
- It acts as storehouse of plant nutrients by holding them due to high cation exchange capacity.
- It provides food and energy to beneficial microorganisms for proper functioning in the soil.
- It improves particle-binding capacity and thereby checks soil erosion.
- Soils supplied with compost become darker in color, which absorbs more heat from sunlight and reduces cold injury to plants, especially during frost nights.
- The root and tuber crops respond better because they require lesser energy to make space for their better growth and development due to high aeration, pulverization etc.
- It provides food to earthworms and increases their population for improving soil fertility.
- It reduces soil pollution and produces crop of healthy and superior quality.

Widespread use of inorganic (chemical fertilizers) nutrients carriers have resulted into several fertility problems in soil, as given below:

- Soil structure gets disturbed and destroyed due to which the porosity declines resulting into poor plant health.
- Soil capillarity gets reduced due to which water management inability pose great threat to agriculture.
- Gradual decline in soil organic matter content results into soil compaction, which has its adverse effect on soil rhizosphere.
- Lack of sufficient organic matter content in the soil causes reduction in population of beneficial microbes, resulting into poor soil fertility.

- Lower organic matter content in the soil leads to deficiency of micronutrients as these micronutrients are absorbed and retained by organic matter, which is not used and gets lost.
- The unscientific application of nitrogenous chemical fertilizers like Urea and Ammonium Sulfate has resulted into widespread acidification of soil.

4.1.4 The Compost Efficiency Test of the Bhaktapur Composting Facility

Under this survey, compost efficiency test of the compost product of Bhaktapur Composting Facility (BCF) has been conducted.

Compost Efficiency Test of the compost product of the BCF has been conducted through Plot Method. The main objective of the test is

- to determine treatment effect of solid waste compost on different crops at field condition.
- to detect residual effect of solid waste compost in soil.
- to find out the actual content of nutrients in solid waste compost by laboratory analysis.
- to demonstrate the effect of solid waste compost at field condition.

The test is done at a site in Bhaktapur using improved variety of tomato plant developed at National Agriculture Research Council (NARC), HMGN. Similarly, another efficiency test is being carried out at controlled environment at NARC premises by planting corn.

4.2 Methodology of Field Trials at Bhaktapur and Khumaltar

At the initial phase, experimental sites were selected at Byasi, Ward No. 15, Bhaktapur Municipality and Khumaltar research farm of Nepal Agricultural Research Council (NARC) under the supervision of Soil Science Division.

The participatory farmer (Mr. Bishnu Bhakta Vaidya) of Bhaktapur Municipality is an intensive vegetable grower. Due to this reason, Mr. Vaidya was selected to conduct field trial in his land. Mr. Vaidya was requested to grow maize at the beginning, but he refused as maize is not a profitable crop compared to vegetables. Another reason was that the farmers have a tendency to get maximum profit from their limited land. Therefore, farmers always prefer to grow high value crops like vegetables. Our second option was cabbage. However, the dry season (March) fall under off-season to grow cabbage and seedling of cabbage in nurseries were not available. Therefore, the team selected tomato crop as the test crop. It was also based on the fact that March month is the normal season for tomato cultivation.

The verities of tomato was '*Anshu*', an improved variety developed at NARC. Tomato seedlings were purchased from the Horticulture Research Center/NARC, Khumaltar, Kathmandu. Individual plot size was laid out by 3 m x 2.5 m or 7.5 m^2 for both control and compost treatments. Composite soil sample was taken for the benchmark study at the time of land preparation. The solid waste compost was applied at the rate of 30 tons per hector in the treatment plot. At the same time, 1 kg compost sample was taken for laboratory analysis at Soil Science Division/NARC Khumaltar. The compost was applied in the treatment plot at a rate of 30 tons per ha. Nothing was applied on the second plot. Tomato seedling was transplanted on March 31, 2005. Row–to-row and plant-to-plant spacing was maintained by 75 cm and 50 cm apart respectively. Four rows were maintained within the plot and five plants were transplanted. Number of plants was 20 in one plot. Right now, tomato plats are attending at fruiting stage. Tomato plants in the compost treated plot are observed to have good and vigorous growth as compared to the control or no compost treated plot. In the mean time, some plants of both the plots were infected by bacterial welting disease. Senior scientists (pathologists) from Crop Science Department and Insect Department of NARC observed the diseased plants in the laboratory. A ccording to them, there are no measures for the control of bacterial welting disease. They also suggested that the welting bacteria was already infected in the farmer's field soil by other mismanagement before plantation of the sample tomato seedlings. According to their advise, only remedy was to remove the infected plant from the trial plots and burn them away from field to save the remaining plants from bacterial welting disease.

In this context, it was decided to conduct an additional field trial of compost at controlled environment of NARC on maize at it’s Khumaltar Research Farm. May month is appropriate time for maize crop cultivation. The composite soil sample was taken before seed sowing for the benchmark study in soil. The Arun maize variety, a developed variety, was selected as test crop, which is short day variety. It could be harvest as green cubs after 90 days of sowing. Maize seed was sown on May 29, 2005. The plot size was laid out by 4.5 m x 3 m or 13.5 m^2 for both control and compost treatment. R ow-to-row and plant-to-plant spacing was maintained by 75 cm and 20 cm respectively. Similarly, the compost was applied at the rate of 30 tons per hector and mixed thoroughly in soil before sowing maize seed. Composite soil sample was taken before sowing maize seed for the laboratory analysis. Six rows were maintained within the plot and 15 maize seed were sown in one row. Total plant population will be 90 within the plots.

4.3 Compost Quality and Soil Quality of Test Plot

Soil Sampling:

Two representative composite soil samples were collected from tomato trial plot of Bhaktapur and maize trial plot of Khumaltar at the time of land preparation for the benchmark study. During the course of sapling, soil auger was used to take sample from 20 cm depth.

Municipal Compost and Soil Sample:

Four compost samples were received from SILT office for laboratory analysis. The compost samples were taken from windrow-1 and windrow-2. Similarly, two compost samples were taken from the compost applied to the tomato and maize crops. Compost and soil analysis method was followed as described bellow:

The compost samples were dried in oven at 1050 C temperature up to 24 hours. Dry compost samples were grained and sieved through 2 mm and 0.5 mm opening of sieve size to determine N, P, K and OC percentage respectively. T otal nitrogen in both compost and soil was determined through the modified Kjeldhal method described by Bremner (1965). The compost analysis for P, and K were determined by the digestion/ashing up to 11000 C temperature. The digested compost was diluted to 250 ml and estimated in flame photometer for total K. Similarly, the diluted compost was color developed by the use of venadomolybdate and the color intensity was measured at 600 nM in spectrophotometer for total P.

The organic carbon content (OC %) of the soil was determined by Walkey-Black method and organic C of the compost was determined by dry weight/ashing methods. The available soil potassium and phosphorus was determined as describe by Jackson (1962) and modified

Olsen et al. (1954) methods respectively. The salt content of the soil (1:1 soil and water) and compost (1:2.5 soil and water) was estimated from an electrical-conductivity (EC) measurement on saturated paste. Electrical-conductivity (EC) of soil and compost samples was determined in electrical-conductivity meter. The electrical-resistance measurement was followed as the method adopted by Whitney and Means, 1897. Saturated soil and compost pests (soil and compost to water ratio of 1:2.5) were prepared for the pH reading. Reaction (pH) for both soil and compost was measured by the use of glass electrode pH meter with calomel reference electrode including salt bridge. Certain weight of dried compost sub-sample was taken out from the origin compost sample and contaminants (foreign particles) were separated and identified manually and expressed in percentage basis.

Two composite soil samples were collected from trials plots for the benchmark study. Four compost samples were collected from the compost applied in the test plots, that was produced in Bhaktapur Composting Facility. The samples are tested in the laboratory of NARC for their quality analysis.

4.4 Analysis

4.4.1 Compost Test Analysis

Result of the quality test conducted on the samples of compost at the controlled laboratory of NARC is presented in following Table 4.4-1.

Table 4.4-1 Quality of Compost

Compost Analysis on Dry weight Basis									
Compost sample	pH.	Total N (%)	Total P (%)	Total K (%)	Org. Comp (%)	Moisture (%)	C/N ratio (%)	Elec. Cond. mS.cm^{-1}	Foreign particles (%)
1. T- compost	5.8	1.13	0.26	3.25	8.24	2.04	7.29	0.95	12.57
2. M- compost	7.4	0.82	0.36	3.14	7.74	3.09	9.43	0.91	14.72
3. Windrow-1	7.9	0.80	0.23	3.36	8.33	3.09	11.04	0.825	2.64
4. Windrow-2	7.2	0.88	0.17	3.59	10.01	2.04	11.37	0.9	4.36

Note: T-compost: → Compost sample (applied to tomato crop)
M-compost: → Compost sample (applied to maize crop at NARC)

Composts reaction (pH) were comprise under the rating of moderately acidic (5.8), slightly alkaline (7.2) and moderately alkaline group. The ranges of total N, P, K percentages were analyzing 0.80 to 1.13, 0.17 to 0.36 and 3.14 to 3.59 respectively. Content of the major nutrients (N, P, and K) in compost depends upon the quality of materials use during the compost making and degree of decomposition rate. Organic carbon (OC) content in the compost sample ranges from 7.74 to 10.01 percentage. Particularly, OC content in the compost plays a vital role in nitrogen element (N) availability or it is a pool of nitrogen in the soil. Moisture content was determined in the compost samples ranges from 2.04 to 3.09 percentage

The ratio of the percentage of carbon to that of nitrogen is termed the carbon: nitrogen ratio, or simply the C: N ratio, which defines the relative quantities of these two elements in fresh organic materials, humus, or in the whole soil body. The C: N ratio of stable soil organic matter is about 10: 1. The C: N ratio of municipal compost samples ranges from 7.29 to 11.37. As a general rule, when organic materials with a C: N ratio of greater than 30 are added to soil, there is immobilization of soil nitrogen during the initial decomposition process. For ratios between 20 and 30 there may be neither immobilization nor release of mineral nitrogen. If the organic materials have a C: N ratio of less than 20, there is usually a release of mineral nitrogen early in the decomposition process (Table 4.2).

Electrical conductivity (EC) was measured in the compost sample and detected the ranges from 0.9 to 0.825 mS cm^{-1}. Normally, the EC value of soil comprises 0-2 mS cm^{-1} under salt free category or class, in which the salinity effect on crops are mostly negligible. Excessive salts hinder crop growth, not only by toxicity effects, but also by reducing water availability through the action of osmotic pressure; nutrient uptake may also become unbalanced.

Foreign particles (contaminants) percentage in the BCF compost samples ranges from 2.64 to 14.72. (Table 4.2). Foreign particles were glass bits, plastics pieces, and iron nails etc. The content of undesirable contaminants in compost is considered less than 3 % on an oven dry basis. The foreign particles not only pose a visual problem but also are a handicap in crop production. Municipal refuse compost has not been recommended for application to paddy fields because of contamination with glass. Heavy metal contamination is also a problem in the compost plant.

The Moisture Content of the compost samples are very low in the range of 2-3 %. It is due to the analysis has been carried out in dried weight basis and not wet weight. Based on past data and windrow study of CKV, 2005, average Moisture Content pf fresh compost will be in the average range of 40 %.

4.4.2 Soil Test Analysis

The result of chemical test of soil sample of the plot where Tomato was planted for conducting compost efficiency test is presented in following Table 4.4-2. Also given is the quality of soil sample at NARC premises where maize has been planted to further validate the compost efficiency.

Table 4.4-2 Benchmark Study of Soil (Chemical Analysis)

Soil Sample	Soil Analysis					
	pH	N (%)	OC (%)	P (%)	K (%)	EC mS.cm^{-1}
T-soil sample	4.3	0.25	3.55	0.031	0.021	0.15
M-soil sample	4.0	0.134	2.02	0.014	0.007	0.10

Note: T-soil: → Soil sample taken from the tomato trial field (Ward 10, Byasi, Bhaktapur Municipakity)
M-soil: → Soil sample taken from maize trial field (NARC, Khumaltar)

Soil reaction (pH) of both tomato and maize trials was found to be extremely acidic (4.0 and 4.3). Total nitrogen content in the tomato soil seems to be medium (0.25 %) and organic carbon content was high (3.55 %). High available phosphorus concentration (0.031 and 0.007 %) in both soils was extracted. On the other hand, high available potassium (0.021 %) and medium available potassium (0.007 %) was analyzed in tomato trial and maize trial soil respectively. The electrical conductivity (EC) value of both soils (0.15 and 0.10 mS. cm-1) was measured and comprises under normal condition, the results are also indicated that there is no any salts contamination problem (Table 4.4-2).

4.4.3 Field Trials Result

The field trail result is discussed in following paragraphs. The yield in terms of number, weight and biomass of the tomato plants are presented in following Table 4.4-3.

Table 4.4-3 Tomato Yield on Farmer's Field Trial

Treatment No.	Tomato Yield (kg 7.5 m^{-2})	Tomato Yield (t/ha^{-1})	Total Number (No./ 7.5 m^{-2})	Total Number (No.ha^{-1})	Fresh Biomass (kg 7.5m^{-2})	Fresh Biomass (t/ha^{-1})
T1. No compost	35.9	47.867	778	10,37773	13.2	17.6
T2. 30 t/ha^{-1} compost	37.739	50.319	10,667	14,22,2666	21.9	29.2

Source: JICA- CKV Study, 2005

The above Table 4.4-3 indicates that higher quantity and better quality of tomato yield and higher fresh biomass was harvested in the plot T2 where compost soil conditioner produced in BCF was applied at the rate of 30 t/ha. Whereas, lower tomato yield and biomass was recorded in the control treatment (T1) or plot without compost application. The result indicates that the compost application in the tomato cultivation is an effective input for better quality and quantity of production of tomato.

Similarly, soil analysis report (Table 4.4-4) indicates that residual effect was found in the compost-applied plot (T2).

Table 4.4-4 Soil sample Analysis after Tomato Harvest (Chemical Analysis)

Treatment No.	Residual Effect in Soil						
	pH	N (%)	OC (%)	P (%)	K (%)	C/N ratio (%)	EC mS.cm-1
T1. No compost	3.7	0.236	1.542	0.0257	0.023	6.534	0.40
T2. 30 t/ha^{-1} compost	4.2	0.262	2.315	0.3163	0.024	8.836	0.35

Note: Research results of maize will be submitted after maize harvest.

Table 4.4-4 also indicates that the compost could have played a major role to supply plant nutrients for sequential crops. N, OC, P and K were analyzed to be in more percentage in the compost applied treatment (T2) plot as compared with control or no compost applied (T1) treatment plot (Table 4.4-4). Phosphorus and potassium percentage are also increased as compared to the benchmark study. Therefore, the compost is the major source for the soil fertility improvement.

Pilot Project B-3

Suggested Layout and Specification for Large-Scale Composting Facility

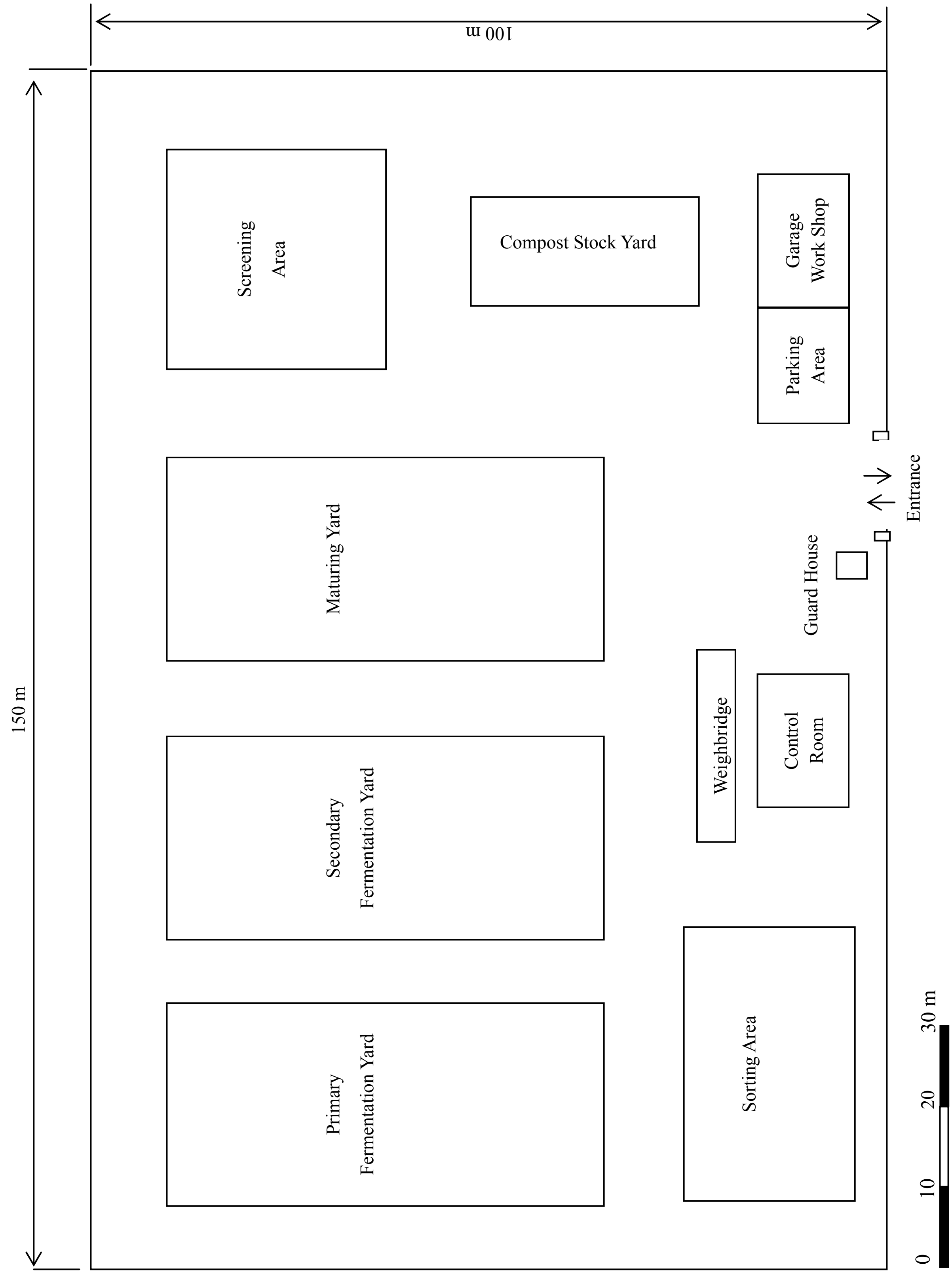


Figure B.3-1 Suggested Layout of 50 t/d Composting Facility

Source: JICA Study Team

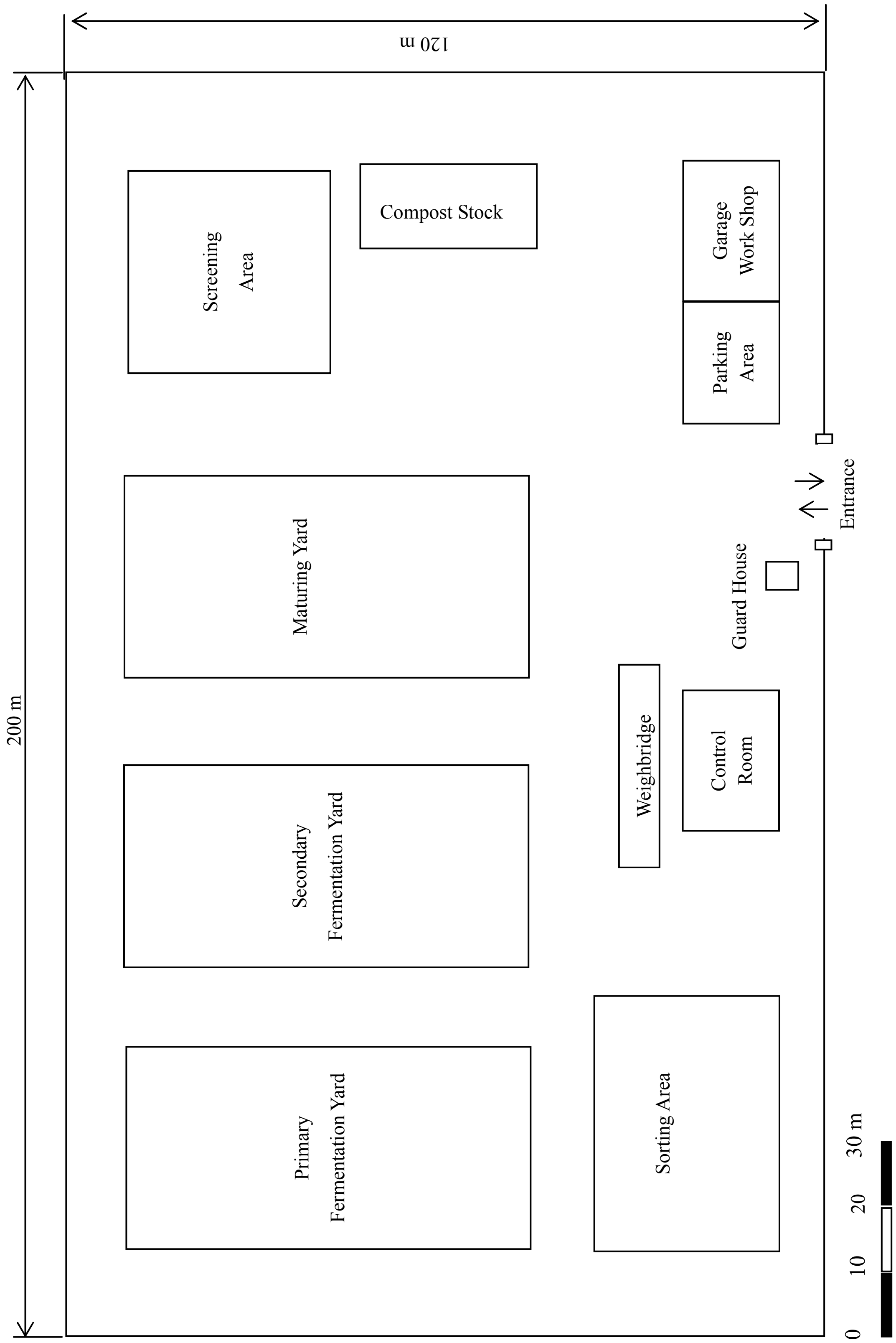


Figure B.3-2 Suggested Layout of 100 t/d Composting Facility

Source: JICA Study Team

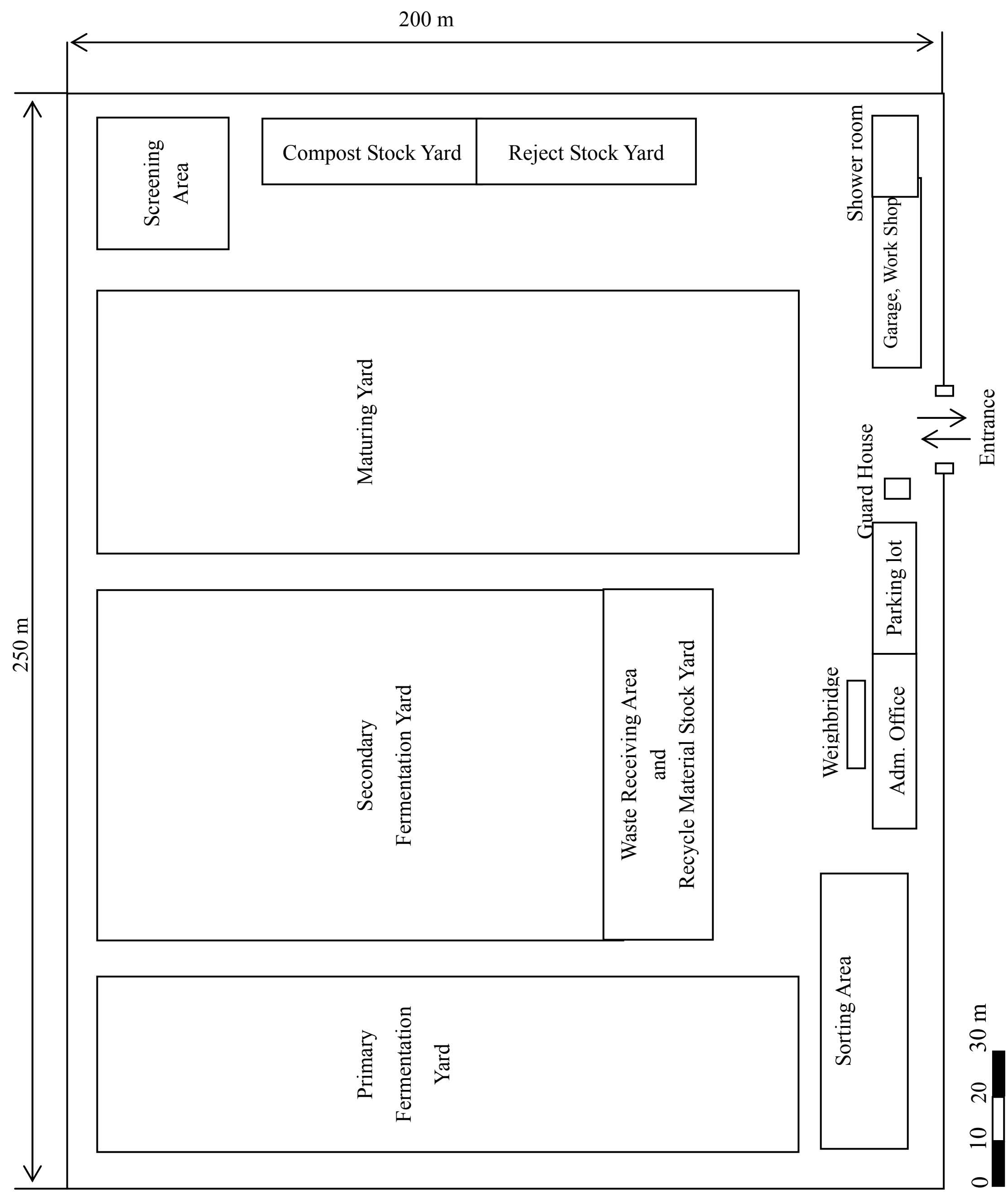


Figure B.3-3 Suggested Layout of 300 t/d Composting Facility

Source: JICA Study Team,

Table B.3-1 Facility and Equipment List

Item	Specification			50t/d	100t/d	300t/d
Civil work	Installation area	Width	m	100	120	200
		Length	m	150	200	250
		Pavement	Concrete			
	Weighbridge foundation	Width	m	4	4	4
		Length	m	20	20	20
		Structure	Steel reinforced concrete			
	Access road	Width	m	6	6	6
		Length	m	500	500	500
		Pavement	Asphalt			
	Fence	Length	m	500	640	900
		Height	m	2	2	2
		Type	Galvanized mesh and trees			
Building	Sorting area	Width	m	15	20	20
		Length	m	20	25	50
		Height	m	5	5	5
		Structure	Roof and breast wall			
	Screening area	Width	m	15	20	30
		Length	m	20	20	30
		Height	m	5	5	5
		Structure	Roof and breast wall			
	Administration office	Width	m	10	10	10
		Length	m	15	20	40
		Height	m	3	3	3
		Structure	with rest room			
	Guard house	Width	m	3	3	4
		Length	m	3	5	5
		Height	m	3	3	3
		Structure	Roof and wall			
	Garage, Workshop	Width	m	20	20	40
		Length	m	5	10	10
		Height	m	3	3	3
		Structure	Roof and breast wall			
	Shower room	Width	m	5	10	20
		Length	m	5	5	10
		Height	m	3	3	3
		Structure	Roof and wall			
Equipment	Weighbridge	Capacity	ton	30	30	30
		Type	Load cell			
	Sorting screen	Capacity	ton/h	10	20	50
		Type	50mm mesh Trommel (Rotary screen)			
	Charging machine	Capacity	m^3	1	1	1
		Number	unit	1	2	3
		Type	Wheel loader			
	Turning machine	Capacity	m^3	2	2	2
		Number	unit	1	1	2
		Type	Wheel loader			
	Screening equipment	Capacity	ton/h	3	5	10
		Type	10mm mesh Trommel (Rotary screen)			
	Miscellaneous	5% of total				
Utility	Water supply	$3m^3/d$, D=50mm				
	Electricity supply	100 KVA, 220V, 3φ				
	Telephone line	1 line				
	Drainage	$3m^3/d$, D=200mm				

Source: JICA Study Team

Table B.3-2 Data for Operation and Maintenance of Composting Facility

Item			Unit	50t/d	100t/d	300t/d
Personnel	Manager		Person	1	1	1
	Engineer	Composting operation	Person	1	1	1
		Equipment operation	Person			1
	Secretary		Person			1
	Driver	Receiving and charging	Person	1	2	3
		Turning and screening	Person	2(2sift)	2(2sift)	4(2sift)
	Operator	Weighbridge operation	Person	1	1	1
		Sorting and screening operation	Person	1	1	1
	Worker	Segregator	Person	5	10	28
		Packing and delivery worker	Person	2	3	6
	Assistance worker	for composting	Person	6(2sift)	10(2sift)	20(2sift)
		for removing glass particles	Person	6(2sift)	10(2sift)	30(2sift)
	Guard		Person	3(3sift)	3(3sift)	3(3sift)
	Total			29	44	100
Operation	Fuel	Consumption	liter/d	4.0	7.2	20
		Running distance	m/time	50	60	100
		Rnning times	time/d	120	120	120
		Total distance	Km	6	7.2	12
		Unit consumption	km/liter	3	3	3
		Consumption	liter/unit	2	2.4	4
		Number of vehicle	unit	2	3	5
	Electricity	Consumption	kwh/d	360	520	976
		Screening equipment	kw	15	22	45
		Conveyor	kw	5.5	7.5	11
		Others	kw	2	3	5
		Total	kw	23	33	61
		Operating time	h/d	16	16	16
	Water	Consumption	m^3/d	3	6	9
		Moisture control	m^3/d	1	2	3
		Cleaning	m^3/d	1	2	3
		Others	m^3/d	1	2	3

Source: JICA Study Team

Pilot Project B-4

Result of Analysis of Compost Quality

Table of Contents

CHAPTER 1 INTRODUCTION

1.1 Background

In the course of the Survey, the JICA Study Team together with the Nepalese counterparts conducted a series of activities as part of the Pilot Projects regarding waste minimization. As part of the activities, the "Compost Quality Survey" has been carried out. This survey mainly focused on quality aspect of compost and perceptions of households towards composting, performance of home composting.

The compost samples were collected from the households who were in charge of composting in Home Composting Bin (HCB) and analyzed. The survey with semi structure questionnaire was also conducted to gain the knowledge on present use situation of distributed HCB, composting performance of HCB, attitude of households on HCB, problems of HCB structure in home composting, problems of HCB for composting and suggestions to improve the present situation for better home composting. In addition, two manuals "How to Use Home Compost Bin" and "Training of Trainers (TOT)" base on the experiences observed in survey were finalized in Nepali and English.

1.2 Objectives

The objectives of survey are as follows:

- To assess home composting activities and the examination of the data for further improvement of the activities.
- To assess compost quality produced in Home Compost Bin (HCB)
- Finalization of Manuals "How to Use Home Compost Bin" and "Training of Trainers (TOT)"

CHAPTER 2 COMPOST SAMPLE COLLECTION AND MONITORING METHODOLOGY

2.1 Compost Sample Size and Sample Site

2.1.1 Procedure for Sample Size Determination

HCBs were distributed in KMC (500 Bins), LSMC (600 bins) and KRM (75 bins) under the Pilot Project B. As the list obtained from SOUP, WEPCO and CDS/LSMC, 1,137 bins had been used for home composting by the residents. The compost sampling was decided selecting those houses who had aged more than three months old compost bins because compost decomposition takes about three months. Firstly, two lists were prepared; a list of households getting HCB, other a list of households who has more than three months older compost. Secondly, random sampling procedure was adopted to select 100 samples from the second list. A list of household was prepared for compost sampling proportionately from each ward of municipalities.

2.1.2 Sample Size and Sample Site

Samples were taken proportionately from each ward of each municipalities. The collected sample was 27 compost samples from KMC, 66 samples from LSMC and 7 samples from KRM as shown in Table 2.1-1.

Table 2.1-1 Sample Site and Sample Size for Compost Sample Collection

Metro-City/ Municipality	Ward Nos.	Total No. of HCB Distributed	Total No. of HHs Doing Home Composting	No. of HHs having 3 Month old Compost*	% Sample (22.5%)	No. Samples Taken
KMC	21	499	499	121	27	27
LSMC	1, 2, 5, 7, 8, 12 and 18	587	587	294	66	66
KRM	1, 5 and 14	51	51	33	7	7
Total	12	1,137	1137	448	100	100

Note: * The Households who have done composting before February 16, 2005 was considered for sampling

2.1.3 Quality Analysis of Compost

Hundred compost samples were collected and given to Agricultural Technology Centre (ATC), Pulchowk, Lalitpur. ATC is the reliable and the propriter has good experiences on compost and soil test for agricultural purposes. Compost samples was analysed in folowing items (componenets).

Table 2.1-2 Compost Test was Analysed in the following Items

S. No.	Compost Test components
1	Moisture Content (%)
2	pH
3	Electric conductivity (EC)
4	Organic Matter (%)
5	C/N Ratio
6	Total Nitrogen (%)
7	Total Phosphorus (%)
8	Total Potassium (%)

2.1.4 Compost Analysis Methods/Procedures

The test results of seven items among above mentioned eight test is obtained by laboratory test and one (CN Ratio) is estimated by calculating test result of Organic Carbon (OC=OM/1.72) and Nitrogen (N). The brief laboratory method of test of Moisture content, pH Value, Electrical Conductivity, Total Nitrogen, Total Phosphorus, Total Potassium and Organic Matter of compost are described below.

1. **Moisture (% O.D.S.)**
   Loss of weight on oven drying (105º C)
2. **pH value**
   A measured quantity of compost is shaken with a convenient volume of salt solution under consistent conditions and the pH of the suspension is determined electronically on a direct reading in pH-meter using a glass electrode with a saturated potassium chloride (KCl)-calomel electrode. A 1:2.5 compost – KCl (1N) ratio is often being used.
3. **Electric Conductivity (EC)**
   The conductivity of compost is the specific conductivity at 25ºC of a water extract obtained from a compost and water mixture at a 1:2.5 ratio. It is measured with a Conductivity Meter and is normally read in m mhos/cm or ms/cm.

4. **Total nitrogen (%)**
For this analysis, Kjeldhal Method is used. Organic Matter is oxidized by treating compost with concentrated Sulphuric acid (H_2SO_4). The digestion of the compost with salicylic acid, sodium-Thiosulphate and Sulphuric acid is facilitated by using Nodium Sulphate (Na_2SO_4) and Copper Sulphate ($CuSO_4$) – catalyses the reaction. The digestion solution liberate the Ammonia on treating with alkali, which is collected in boric acid solution and titrated with standardized acid using mixed indicator.

5. **Organic Matter (%)**
Walkley-Black Method. Oxidizable organic matter in the compost is oxidized by Chromic acid in the presence of Sulphuric acid. The excess Chromic acid is determined by titrating with Ferrous Ammonium Sulphate solution (assumes 77% oxidation).

Decomposition of sample (compost) by Sodium Carbonate (Na_2CO_3). Fusion for Potassium and Phosphorous determination.

6. **Phosphorous (P_2O_5%)**
The Phosphorous content in the fused aliquot (sample) is made with Chlorostannous reduced Molybdophosphoric blue color method. The blue color is measured by colorimeter.

7. **Potassium (K_2O%)**
The Potassium content in the fused aliquot is diluted and directly measured by Flame Photometry.

8. **Carbon Nitrogen Ratio (C:N Ratio)**
Organic Carbon is the ration of Organic Matter and 1.72 (factor) i.e. Organic Matter/1.72. C.N Ratio is the ratio of Organic Carbon to Nitrogen i.e. Organic Carbon/ Nitrogen. C:N Ratio = Organic Matter (%)/1.72 X Nitrogen %)

To maintain the quality control in each batch, one reference sample and one blank sample included and checked after each 10 samples.

2.2 Monitoring of Home Composting in Home Compost Bin

2.2.1 Sample Size Determination and Monitoring Sites

A set of questionnaire was designed to HCB users with few questions related to present use situation of distributed HCB, composting performance of HCB, attitude of households on HCB, purpose of composting, continuity of home compost production, problems of HCB (structure) in home composting, problems of HCB for composting and suggestions to improve the present situation for better home composting.

The questionnaire was interviewed to all households from where compost samples were collected, thus 100 households were interviewed.

2.2.2 Key Informant Survey

A set of Key Informant was designed and interviewed to SOUP, WEPCO, CDS/LSMC to have their collective idea on HCB. SOUP, WEPCO, CDS/LSMC were directly associated with home compost training, bin distribution and monitoring. The Key Informant mainly includes number of groups trained, numbers of trainees, performance of HCB, purpose of home composting, use of produced compost, problems of bin (bin structure) for composting, continuity of home compost production and problems in compost production in HCB.

2.2.3 Focus Group Discussion

Focus group discussion was held in few survey sites (Kirtipur-5 and CDS/LSMC) and group discussions were followed on performance of HCB, purpose of HCB, problems in HCB (structure) and problems in composting in HCB. The discussions were mainly concentrated on its performance and problems.

2.2.4 On Site Visit and Observations

On site observations were carried out to find the performance of composting in HCB, practices of putting biomass or home waste in bin, purpose of home composting, problems of bin for home compost production.

2.3 Finalization of Manuals

The survey team has revised the manuals "How to Use Home Compost Bin" and "Training of Trainer (TOT)" and has prepared in Nepali and English Version as original document. The manuals consisted required figures for betted self expalnation and texts are made more simple and used most common language for easy understanding. The revision of manuals are based on the information and feed back responded by the HCB users and agencies associated with HCB activities as SOUP, WEPCO and CDS/LSMC.

Chapter 3 SURVEY FINDINGS

3.1 Findings of Quality Analysis of Compost

3.1.1 Result of Compost Analysis

The laboratory results of 100 compost samples produced from Home Compost Bin (HCB) by municipalities are presented in the Table 3.1-1. The overall average result of samples are given pH as 7.7, moisture content of compost as 40.0%, Organic Matter 11.9%, Nitrogen as 1.13%, P_2O_5 as 0.70%, K_2O as 3.49%, Electrical Conductivity as 1.33 (mmhos/cm) and C:N ratio as 6.7. The average analysis results of KMC (27 samples), LSMC (66 samples) and KRM (7 samples) shows that no great differences are observed except to Organic Matters but variations are great to individual bin to bin. The average and ranges of nutrients content of compost produced in HCB is presented in Figure 3.1-1 and by Municipality/Metro City is presented in Figure 3.1-2.

Table 3.1-1 Results of Laboratory Analysis of Compost

MC/MP	pH	Moisture (%)	O.M. (%)	Total N (%)	Total P_2O_5 (%)	Total K_2O (%)	EC{1:5 Extract} (mmhos/cm)	C:N Ratio
KMC Average	7.92	41.16	11.53	1.16	0.62	2.94	1.48	6.18
LSMS Average	7.66	39.51	12.50	1.15	0.76	3.71	1.26	7.09
KRM Average	7.79	40.16	7.76	0.83	0.52	3.49	1.35	5.56
Overall Average	7.74	40.00	11.90	1.13	0.70	3.49	1.33	6.74
Range	6.2 - 9.0	12.7 - 71.2	2.1 - 35.8	0.30 - 3.02	0.42 - 2.02	3.01 - 5.69	0.62 - >2.0	1.1 - 31.8

Source: Laboratory Analysis of compost was done in Agriculture Technology Center, Pulchaok, Lalitpur. Analyzed Date: June 2005.

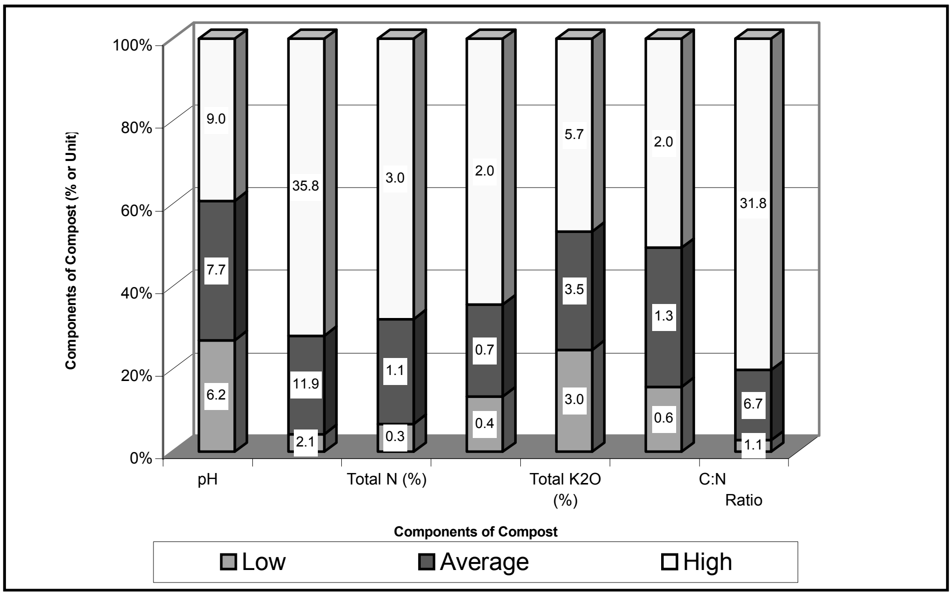


Figure 3.1-1 Nutrients Content of Compost Produced in Home Compost Bin

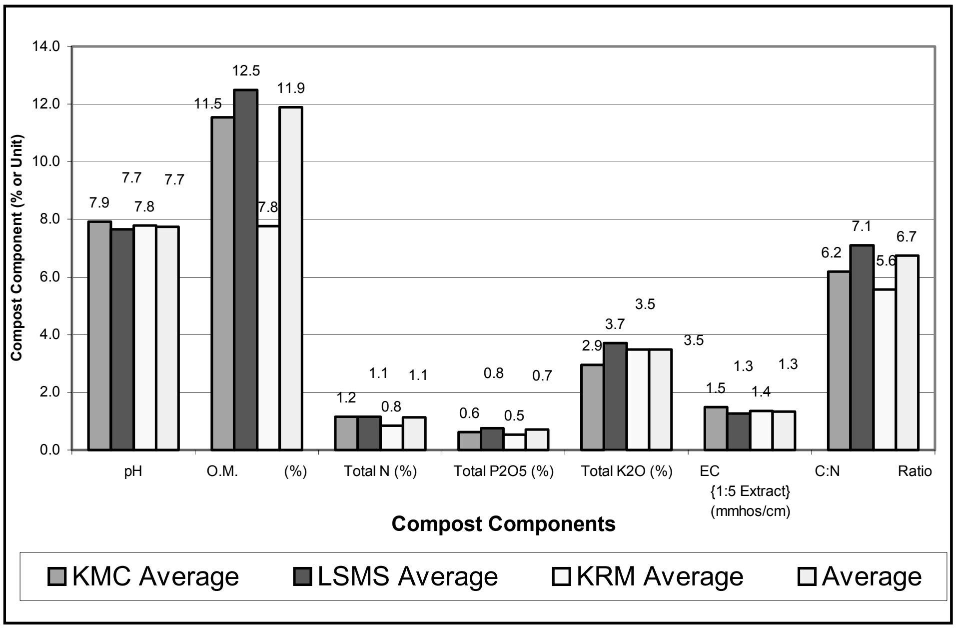


Figure 3.1-2. Nutrients Content of Compost Produced in Home Compost Bin by municipalities

3.1.2 Nutrient Contents of Compost Produced from Different Methods/Sources

The compost is main manure for crop nourishments. The fertilizer is the invention made for the supplement of nutrients to the plants. Fertilizer contains particularly few nutrients as two or three but manure and compost (prepared by improved technology) numerous nutrients that are in lower quantity some nutrients in trace. In this survey, few compost components were analyzed as pH, OM, Nitrogen, Phosphorus, Potassium, EC, compost moisture and CN ratio. But most of the agencies involved in compost business do analyze only few major nutrients as pH, OM, Nitrogen, Phosphorus and Potassium. In the same way, a table is presented below showing the nutrient content of compost produced from different methods/sources. The comparative study of compost components produced from different methods/sources with the source of information is summarized in Table 3.1-2 and graphically presented in Figure 3.1-3 and Figure 3.1-4.

Table 3.1-2 Nutrients Content of Compost/Manure from Different Source

MC/MP	pH	O.M. (%)	Total N (%)	Total P_2O_5 (%)	Total K_2O (%)	Source of Information
Compost (HCBin)	7.7	11.9	1.13	0.70	3.49	Present Study
SW-C Bhaktapur (W1)	7.9	8.33	0.80	0.23	3.36	JICA Study Team
SW-C Bhaktapur (W2)	7.2	10.01	0.88	0.17	3.59	JICA Study Team
Farm Yard Manure (Nepal)			0.3-0.5	0.10-0.15	0.35-0.5	TMQC(N)-FADINAP
Compost (Nepal)			0.50	0.20	0.50	TMQC(E)-FADINAP
Rural Compost (India)			0.50 - 1.00	0.40 - 0.80	0.80 - 1.20	HB of Agri. (ICAR)
Farm Yard Manure (India)			0.40 - 1.50	0.30 - 0.90	0.30 - 1.90	HB of Agri. (ICAR)

Source: TMQC(N) = Training Manual on Quality Composting (Nepali), Soil Science Division, Nepal Agriculture Research Council (NARC) / Fertilizer Advisory Development and Information Network for Asia and Pacific (FADINAP), 2002.

Source: TMQC(E) = Training Manual on Quality Composting (English), Soil Science Division, Nepal Agriculture Council (NARC) / Fertilizer Advisory Development and Information Network for Asia and Pacific (FADINAP), 2001
Hand Book of Agriculture, Indian Council of Agricultural Research (ICAR), 1980

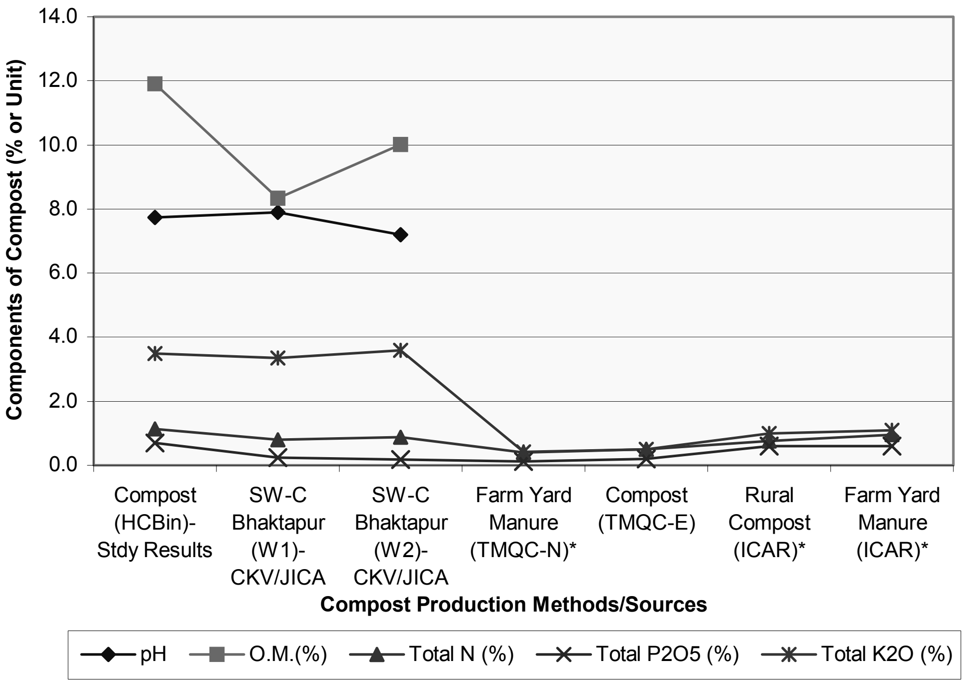


Figure 3.1-3 Comparative Study of Compost Produced from Different Methods/Sources (Average value of given range)

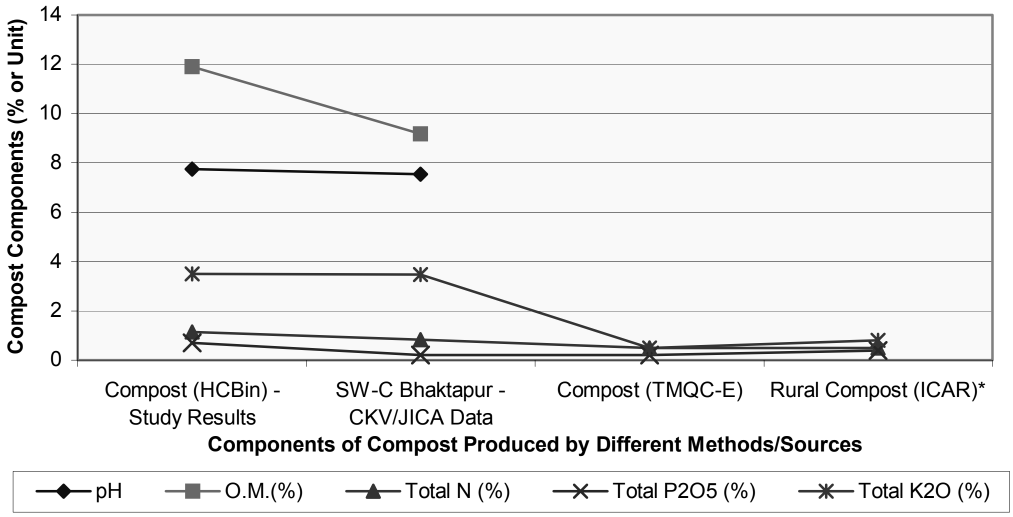


Figure 3.1-4 Comparative Study of Major Compost Components Produced from Different Methods/Sources (lower range is taken)

Compost pH: pH observed from the analysis of compost produced in HCB is found slightly upper side but not so high. The pH reported by SW-C (BKM) and improved compost is and pH rate from HCB are more of over in same range. The pH of compost produced in HCB is of better pH or within better limit.

Organic Matter: Organic Matter (OM) is little than improved compost but better than SW-C of Bhaktapur and farmers' compost. The OM of home compost bin is 11.9% whereas OM of BKM is 10.0% and farmers' compost is 8.0 to 10.0. The OM content of compost produced in HCB is better than SW-C produced in BKM and farmers' compost but higher the content better to soil and better soil health.

Nitrogen: Nitrogen is 11.9%, which is higher than SW-C of BKM and farmers' compost. It can be concluded that Nitrogen content of HCB is better than any other average compost. HCB has produced better Nitrogen content compost but it basically depends on composting materials.

Phosphorus: Phosphorus is 0.70%, which is quite higher than SW-C of BKM and farmers' compost. Phosphorus content of HCBs' compost is containing higher amount than any other average compost. HCB has produced better Phosphorus content compost.

Potassium: Potassium is 3.49%, which is quite higher than any other compost. The HCB has produced better Phosphorus content compost.

3.1.3 Quality of Compost Produced in Home Compost Bin

The nutrients content (N, P_2O_5 and K_2O), organic matter content and pH of home compost were found better than other compost produced by different sources and produced/reported in different reports. The main reasons of quality home compost might be that in home composting 1. Purely organic wastes are used; 2. Organic wastes are mostly kitchen waste (green matter) which contains high nutrients; 3. No single pieces of inorganic wastes are used (no decomposable matters are used); 4. Adopted technologies of home composting; 6. Inoculums (EM, Bokasi, Top soil, old compost) are used which it self contains high nutrients; 7. Each bin users are well trained and supported by providing training manual; and 8. Each bin users are paying more attention in home composting because a. Home composting was closely related to reduction of home pollutions so much more attentions are paid; b. Quantity handling per day is small so greater attention could be paid well; c. Product (compost) is available at home, have not to bother going other places in search of compost and no immediate payment is needed; d. Product (compost) of home compost can be immediately used for gardens, flowerpots and agricultural purposes; and e. some has taken home composting as hobby to reduce pollutions. In overall, the compost produced from Home Compost Bin has contained good proportion of nutrients.

3.1.4 Compost Preparation in Home Compost Bin

Processes Involved in Composting

Compost is the product of natural process of decomposition of organic waste. In the process of decomposition the organic waste starts to decompose and convert the waste materials into dark brown product and friable as soil like product. To enhance the decomposition processes an optimum environment and conditions should be provided to microbes. In absence of congenial environment, the microbes will take longer time for decomposition. The length of decomposition period depends on the composting materials used. Thus, sugars, water-soluble protein, are the readily available energy source for soil organism but cellulose, hemicelluloses is relatively slowly decomposable and lignin are very resistant source of food, although they eventually supply much total energy.

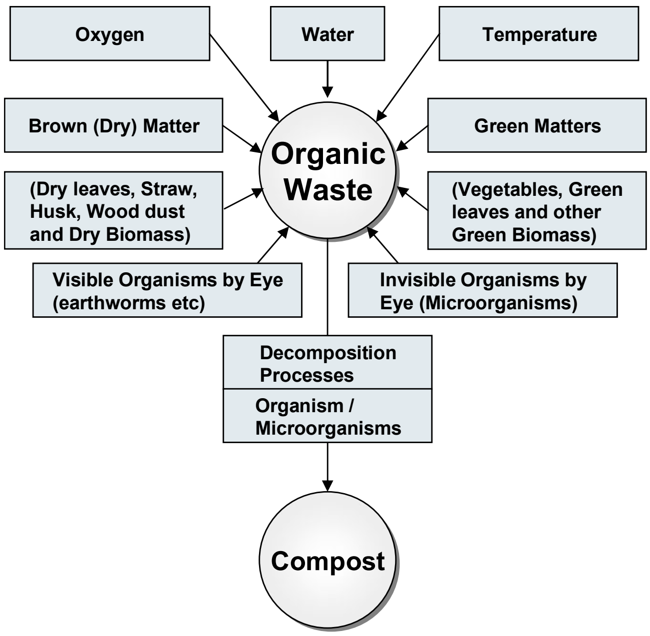


Figure 3.1-5 Aerobic Decomposition Processes of Organic Waste

Conditions Required for Compost Preparation

a **Cutting the Organic Waste into Small Pieces:** As the wastes are of larger in size and hard, it will be difficult for decomposition to microbes. As a result, it will take longer time for decomposition. Therefore, it is important to cut organic matter into small sizes of about one to two inches sizes. As the size of waste materials become smaller and smaller better and earlier the decomposition of waste materials.

b **Balancing the Dry Matter (Brown Matter) and Green Matter**: Both brown matter and green matter should be mixed in organic wastes. Brown matter likely contains high Carbon as sawdust, straw, dried leaves etc. Carbon provides energy to the microorganisms. Green matters like vegetables, grass, cow dung etc contains higher proportions of Nitrogen. Nitrogen provides nutrients to the microorganisms. Therefore, proportion of brown matters and green matters is important in composting therefore due attention should be given that whether both matters are proportionately mixed or not.

c **Temperature Management**: Microorganisms become inactive in low temperatures consequently decomposition processes are lengthens. Therefore, if the temperature drops down inside bin some urea and old compost can be added to fasten the process of decomposition.

d **Air Circulation**: Microorganisms require oxygen in decomposition process. Therefore, there should be good air circulation provision for composting. Air holes should be provided in order to ensure a good airflow.

e **Moisture Management**: Microorganisms become inactive both in dry and very moist conditions. Therefore, the moisture content of biomass should be in optimum condition. 50 to 60% moisture content is taken as good moisture condition for waste decomposition.

f **Use of Inoculums (Jodan):** To activate the decomposition process certain microorganisms are required, those microbes are called inoculums (Jadan). Curd can be made from milk without mixing curd (inoculums) but milk could be fermented quicker if some curd (inoculums) is mixed in milk. Similarly, inoculums are needed for composting in order to fasten the decomposition process. The inoculums are abundantly found in topsoil (surface soil) of cropland, compost and EM (Effective Microorganisms). Therefore, these materials are used as inoculums source. Any of the above inoculums help to fasten decomposition.

3.1.5 Major Functions of Elements/Nutrients

The role of major plant nutrients is described below. Plant needs sixteen essential elements to the plant growth and mostly they are derived from soil and air. The transport medium is the soil solution. Carbon is derived from air as CO_2 and from water Hydrogen (H) and Oxygen (O) and rest of nutrients from soil. Nitrogen, Phosphorus and Potassium are the major nutrients for plants.

<u>Nitrogen:</u> Plant constitute 1 to 4% of dry weight of the plant is taken up from the soil. The main functions of Nitrogen are as follows:

- Helps in carbohydrate metabolism in the plant to form amino acids and protein.
- It is the motor of plant growth.
- It is essential constituent of protein.
- It is involved in all major processes of plant development and yield formation.
- It helps to proportionate uptake of other nutrients.

<u>Phosphorus:</u> Plant constitutes 0.1 to 0.4% of the dry matter in the plant. The main functions of Phosphorus are as follows:

- It plays major role in the transfer of energy.
- It is essential for photosynthesis and other chemico-physiological processes in the plant.

- It is indispensable for cell differentiations and for the development of tissues that form the growing points of the plants.

Potassium: Plant constitutes 1.0 to 4.0% of the dry matter in the plant. The main functions of Potassium are as follows:

- It activates more than 60 enzymes and play vital role in carbohydrate and protein synthesis.
- It improves the water regime of the plant and increases tolerance to drought, frost and salinity.
- It makes plant cell stiff cause less affect of diseases.

Organic Matter: Organic materials should be well decomposed before application to the land. It is the sources of organic carbon, which constitute major portion of pant constituents. The main functions of Organic Matter are as follows:

- It is not only valuable not only because they supply plant nutrients but also improves soil condition.
- It improves the structure, reduces soil erosion, ha a regulating effect on soil temperature and helps to the soil to store more moisture.
- It makes better use of mineral fertilizer.
- Its combination with fertilizer provides the ideal environment conditions for the crops, as the organic matter improves soil properties and nutrient supply.
- It helps to improve physical, chemical and biological condition of soil and enhances water holding and nutrient holding capacity of soil.

pH: The pH of compost will affect soil pH but not so greatly. The pH of soil greatly affects on element availability and nutrient uptake by plants. All the elements become available in neutral point and availability decreases at high or low pH with some exception. PH is affected by soil origin, its formation, type of fertilized applied, type of crops grown and amount of organic matter used. In the paddy land, the soil pH comes to neutral points during paddy cultivation being flooded condition.

Electrical Conductivity (EC): It measures the salt concentration in the medium. There is no much importance of EC test in compost. But it is important in soil. It expresses the presence of salt in the soil and its effect is much related with cations and soil pH.

Role of C N Ratio in Compost Decomposition: CN ratio is an important factor in composting. The proportion of dry matter and green matters has to be well proportionated for better decomposition and quality compost. Carbon is the main source of energy and Nitrogen for nourishments to microorganisms.

3.2 Findings of Monitoring of Home Composting Activities

3.2.1 Waste Amount in Home Compost Bin

The households are putting home waste (kitchen waste) in bins for compost production. As information obtained from the Home Compost Bin users, 48% of the bins were found fully filled up (one-fourth of bins' volume) and 49% bins were found half full and about 3% bins had less than half full. The compost preparation being a continuous process of filling the bins and getting out compost from lower compartment (bin door), the bins will be always filled up more than half volume but not full. Waste matter amount situation in HCBs during survey is presented in Table 3.2-1.

Table 3.2-1 Amount Home Waste Material in HCB for Composting

(Unit: %)

Municipality	Waste Amount			Size of Waste			Waste balance	
	Few	Half	Full	Small	Medium	Large	Good	NG
KMC Average	7.4	81.5	11.1	7.4	88.9	3.7	96.3	3.7
LSMC Average	1.5	33.3	65.2	12.1	69.7	18.2	86.4	13.6
KRM Average	0.0	71.4	28.6	0.0	85.7	14.3	100.0	0.0
Overall Average	3.0	49.0	48.0	10.0	76.0	14.0	90.0	10.0

Source: Household Survey, May 2005

3.2.2 Piece Size of Waste Materials in HCB for Composting

It was instructed to the trainees during training that the waste materials should be cut into pieces (1 to 2 inches) and put into HCB to result better decomposition. The greater the surface area of composting materials higher the contact of organism with composting materials and better the decomposition in shorter duration. The result of survey about piece size of materials kept in HCB is presented in Table 3.2-2. The table shows that 76% of bins have been found medium size of waste materials kept in the bins and 10% bins were found putting well chopped in small pieces kept in the bins and 14% bins were found as neglected or large pieces were kept in bins as reported.

3.2.3 Waste Balance of Brown and Brown Waste Materials in HCBs

The proportion of green and brown waste materials plays great role in decomposition and finally the quality of compost. Narrow C:N ratio decay rapidly and yield more humus than do tissues with a smaller amount of nitrogen. As indicated in Table 3.2-2, 90% of bins were found having good combination of green and brown waste materials and rest of the bins (10%) found some negligence in putting waste materials in proper proportion.

3.2.4 Air Flow or Air Circulation in HCB

Organic material decomposition is an oxidation process associated with microbial activities. Decomposition process can be accomplished with aerobic decomposition (decomposition in the presence of Oxygen) and anaerobic decomposition (decomposition in the absence of Oxygen). Aerobic decomposition is the beneficial process of organic waste for quality compost production and anaerobic decomposition leads to nutrient losses and produce bad odors causing leachate problems. The anaerobic process is induced by lack of airflow or lack of air circulation inside the biomass, which is caused by high moisture content. As responded by bin users, 98% of households have responded that bins are such made that it is well aerated but some time it is suspected that it is more aerated than necessary (Table 3.2-2).

Table 3.2-2 Air Flow or Air Circulation in HCB

(Unit: %)

MC/MP	Air Flow		Temperature			Moisture		
	Good	Not Good	High	Suitable	Low	Moist	Suitable	Dry
KMC Average	100.0	0.0	0.0	96.3	3.7	0.0	85.2	14.8
LSMC Average	97.0	3.0	6.1	75.8	18.2	1.5	93.9	4.5
KRM Average	100.0	0.0	14.3	71.4	14.3	28.6	57.1	14.3
Overall Average	98.0	2.0	5.0	81.0	14.0	3.0	89.0	8.0

Source: Household Survey, May 2005

3.2.5 Temperature of Biomass in the HCB

As indicated in Table 3.2-2, 81% of bins had been found suitable temperature (it could be felt warm when palm placed above the surface of biomass) and 14% responded low temperature. Temperature inside the biomass indicates decomposition process is under process having suitable decomposition environment. The atmospheric temperature might play some role in temperature equilibrium but temperature in the biomass is produced by oxidation process or microorganism action.

3.2.6 Moisture Content of Biomass in the HCB

Moisture content of biomass is essential for decomposition but low moisture content reduce the microbial activities and at saturation condition induce anaerobic decomposition. Thus, 350 to 60% moisture content of biomass is appropriate moisture content for organic decomposition. During monitoring the bins, 89% bins found having suitable moisture content, few bins (8%) with dry condition and 3% bins having high moisture or leachate problems. The moisture problems generally appeared depending on the placement of bins and nature and types of biomass kept in the bins. The high moisture or leachate problems occurred when the bins are placed in the ground floor where no light transaction or very dumpy place and bulk of biomass kept without slight withered condition (Table 3.2-2).

3.2.7 Organic Waste Production

The HCB is initiated to distribute for minimization of solid waste produced from households and use them for productive purpose by making them compost. The monitoring result has shown that about less than a kg (0.840 kg/day) is produced from individual households and used them home composting. It is also observed than 90% of households produce less than a kg organic waste and about 10% households produces more than one and half kg of organic waste. Most of the households found using kitchen waste (home waste) for composting and very few of them found using farm waste for composting. The amount of home waste production in monitored households is presented in Table 3.2-3.

Table 3.2-3 Organic Waste Production and Inoculums Used to Biomass for Decomposition

(Unit: %)

MC/MP	Home Waste Produced by Households/Day (kg)					HHs Using Inoculums		Types of Inoculums Used by HHs					
	Amt. (kg)	<0.5	0.5	1.0	>1.5	Yes	No	EM	Bokasi	T. Soil	Comp.	Ash	NU
KMC Average	0.68	14.8	51.9	29.6	3.7	48.1	51.9	0.0	0.0	40.7	0.0	44.4	96.3
LSMC Average	0.88	7.6	39.4	39.4	13.6	86.4	13.6	22.7	13.6	43.9	24.2	37.9	7.6
KRM Average	1.07	0.0	14.3	71.4	14.3	71.4	28.6	14.3	0.0	42.9	0.0	14.3	28.6
Overall Average	0.84	9.0	41.0	39.0	11.0	75.0	25.0	16.0	9.0	43.0	16.0	38.0	33.0

Source: Household Survey, May 2005

3.2.8 Use of Inoculums for Home Composting

The households using inoculums for home composting and types of inoculums used by households is given in Table 3.2-4. As shown in above table, 75% of households are using different types of inoculums to accelerate composting activities faster and for quality compost production. The different types of inoculums used by the households were EM (Effective Microorganisms), Bokasi (made from EM), topsoil (surface soil), compost (old compost) and ash. In total 67% households found using inoculums and reset of the households have not used any inoculums. Out of the inoculums users, about 43% of households found using topsoil as inoculums, 38% found using ash (ash of burned materials), 16% found using compost and 9% Bokasi. Ash itself is not an inoculums but it helps to create congenial environment to microbes.

3.2.9 Time Taken for Home Compost Preparation and Compost Quality

Duration for Home Compost Preparation

Compost production in Home Compost Bin is the first experience and many things are not rightly known. Compost production is the decomposition of biomass, which requires certain bio-environment conditions for better and quicker decomposition. The Bin users were asked about their experiences on composting time in HCB, quality of compost produced in HCB, purpose of making compost and how is the attitudes on HCB. As responded by households, 65% of households responded as the compost preparation takes about 3 months, 12% reported compost was prepared in 2.5 months, 16% said compost was prepared in 2 months and about 7% households expressed it was delayed than as instructed which took more than 3.5 months (Table 3.2-4).

Table 3.2-4 Time Taken for Home Compost Production and Compost Quality

(Unit: %)

<table>
<tr><th rowspan="2">Municipality</th><th colspan="4">Durstion for Compost Preparation Months</th><th colspan="3">Happiness of HHs with HCB Use</th><th colspan="3">Quality of Produced Compost</th><th colspan="4">Purpose of Compost Making</th></tr>
<tr><th><2.0</th><th>2.5</th><th>3</th><th>3.5</th><th>Happy</th><th>NH</th><th>FD</th><th>Good</th><th>NG</th><th>NI</th><th>Home Garden</th><th>Agri. Use</th><th>Income Gener.</th><th>Envir. & Pollution</th></tr>
<tr><td>KMC Average</td><td>0</td><td>0</td><td>27</td><td>0</td><td>100.0</td><td>0.0</td><td>0.0</td><td>74.1</td><td>0.0</td><td>25.9</td><td>63.0</td><td>0.0</td><td>14.8</td><td>66.7</td></tr>
<tr><td>LSMC Average</td><td>16</td><td>12</td><td>31</td><td>7</td><td>98.5</td><td>1.5</td><td>0.0</td><td>68.2</td><td>1.5</td><td>30.3</td><td>63.6</td><td>31.8</td><td>21.2</td><td>57.6</td></tr>
<tr><td>KRM Average</td><td>0</td><td>0</td><td>7</td><td>0</td><td>100.0</td><td>0.0</td><td>0.0</td><td>57.1</td><td>0.0</td><td>42.9</td><td>57.1</td><td>42.9</td><td>0.0</td><td>85.7</td></tr>
<tr><td>Overall Average</td><td>16</td><td>12</td><td>65</td><td>7</td><td>99.0</td><td>1.0</td><td>0.0</td><td>69.0</td><td>1.0</td><td>30.0</td><td>63.0</td><td>24.0</td><td>18.0</td><td>62.0</td></tr>
</table>

Source: Household Survey, May 2005
Note: NH = Not happy, FD = Family disagree ness, NI = No idea, NG = Not good.

Attitude of HCB Users' towards HCB

The attitude of households towards HCB is presented in Table 3.2-4. Almost all users (99%) have expressed their happiness having the HCB except one out of 100 households. There were two main reasons that one; one of the family member had regular duty to take home waste daily to waste container to throw the home waste, now they have not to do so, second; instead they are preparing compost and using them in productive purposes either by using in garden or agriculture purposes.

Quality of Compost Produced in HCB

The HCBs were distributed to prepare compost in HCBs at home level and use them in productive purpose and reduce home waste at the source. The impression of HCB users to the compost quality produced in HCB is gathered and presented in Table 3.2-4. The result has indicated that 69% of households have expressed that the produced compost is of good quality and 30% households could not justify the quality and just said unawareness (no idea) of quality but were satisfied with physical appearance of compost and one household was not satisfied with the product saying compost was not of good quality.

Purpose of Home Compost Production

Just to know the purpose of home composting a question was inserted in the questionnaire. Some of the households have given more than one answers saying some households might have double purposes. The response of households to this question is presented in the Table

3.2-4. About 63% of households answered to that question saying that home composting is done to manure garden (manure to flowers either in garden or pot) and other 62% said to reduce home pollution or improve environment, 24% households expressed that they are using in farming (manure to crops) and about one-fifth of households suggested it could be as income generation activity.

3.2.10 Home Compost Training

Home Compost Training

The result of survey on home composting training is presented in Table 3.2-5. All most all (99%) bin users are trained on home composting and then HCBs were distribution. Each household has used HCBs for composting and doing best use of it.

Table 3.2-5 Home Compost Training

(Unit: %)

	Attaining Compost Training in HCB		Received HCB Manual		Reading HCB Manual		If can not read, Who helps to Explain about HCB Manual					
Municipality	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Son**	**Daug.**	**Husb**	**G.Dau**	**Friend**	**DIL**
KMC Average	100.0	0.0	100.0	0.0	77.8	22.2	3.7	14.8	0.0	3.7	0.0	0.0
LSMC Average	98.5	1.5	100.0	0.0	89.4	10.6	1.5	4.5	1.5	3.0	1.5	1.5
KRM Average	100.0	0.0	85.7	14.3	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Overall Average	99.0	1.0	99.0	1.0	87.0	13.0	2.0	7.0	1.0	3.0	1.0	1.0

Note: Daug. = daughter, Husb = husband, G.Dau = grand daughter, DIL = daughter in-law
Source: Household Survey, May 2005

How to Use Home Compost Bin Manual

The Table 3.2-5 shows that 99% of trainees have received manual "How to Use Home Compost Bin" during training. Under the waste minimization pilot project, bins were given to all trainees who were interested to home composting.

Reading of Manual by Trainees

The training manual was distributed to all trainees during training. The training manual consists of figures for self-explanation and common and simple words are used for easy understanding. One of the mottos of survey is to find out how many percent of trainees can read the manual and understand them. As indicated by the survey, 87% of the participants could read the manuals themselves and 13% of them (illiterate) has to take the helps of others to understand contents of manual (Table 3.2-5). Daughter (7%), grand daughter (3%), son (2%), husband (1%), friend (1%) and daughter in-law (15%) were the main helper to educate about manual.

3.2.11 Problems Encountered in Home Compost Production

Problems Faced in Home Composting Bin

The main problems faced in HCBs are presented in Table 3.2-6. About 81% of bin users did not expressed any problems in bin and bin structure (manufacture design) but rest of users (19%) listed some problems in bin design. 17% of users complained that the door of bin is week which created rat problems, 6% of users argued the iron compartmental frame saying as week and not well adjusted in its position and 2% of users said distributed bins are smaller in size. It was noticed during field visit that the edge of door are sharp some time it has hurt to workers when hands are inserted inside the bin during compost collection or drawing out the compost from bin.

Table 3.2-6 Problems Encountered in Home Composting

(Unit: %)

Municipality	Problems of Bin (Structure) for Composting in HCB				Problems to Prepare Compost in HCB					
	1	2	3	NP	1	2	3	4	5	NP
KMC Average	0.0	0.0	0.0	100.0	66.7	7.4	7.4	3.7	0.0	33.3
LSMC Average	25.8	9.1	3.0	71.2	50.0	1.5	0.0	9.1	9.1	43.9
KRM Average	0.0	0.0	0.0	100.0	28.6	14.3	0.0	14.3	0.0	57.1
Overall Average	17.0	6.0	2.0	81.0	53.0	4.0	2.0	8.0	6.0	42.0

Note: 1. Problems in HCBs are: 1.Week door of bin so more rat attack, 2. Compartment frame is week and not well-adjusted 3. Size of bin is smaller and NP = No Problems
2. Problems in composting in HCBs are: 1. Insect problem, 2. Bad odor, 3. Rat problem, 4. Leachate problem and 5. chopping of waste materials (regular chopping feel boderation)

Source: Household Survey, May 2005

Problems Encountered in Compost Preparation in HCB

The bin users raised numbers of problems as insect problems near by bins some times around house, bad odor, rat problems in the bins and some time entered inside house, leachate problems and regular chopping as problems (Table 3.2-6). As presented in the table, 42% of users did not express any problems in preparing compost in HCB but rest of the users reported different problems. 53% of users complained insects' problems near bin and some time around house, 8% of users stated leachate problem and other said regular chopping is also a problem (6%), bad odor (4%) and rat problems (2%). Later these problems were minimized as the users tried to cope up with problems and improving in composting technique.

3.2.12 General Comments and Suggestion given by HCB Users

General Comments on HCB

Bin users have no so big comment on HCBs. 96% of bin users did not report any comments and are satisfied with present design of bins and few users (3%) have comments on HCBs saying that bins are smaller in size and some users (1%) said daily working with compost business is a tedious job. The general comments and suggestion informed by bin users is presented in Table 3.2-7.

Table 3.2-7 General Comments and Suggestions given by HCB Users

(Unit: %)

MC/MP	General Comments on HCB			Suggestions on HCB							
	1	2	NC	1	2	3	4	5	6	7	NS
KMC Average	4	0	96	33	4	4	4	0	0	0	59
LSMC Average	3	2	95	39	0	0	5	2	2	2	52
KRM Average	0	0	100	29	0	0	0	0	0	0	71
Overall Average	3	1	96	37	1	1	4	1	1	1	55

Note: 1. Comments are: 1. Size of bin is smaller, 2. Regular working with compost is tedious job and 3. NC = no comments.
2. Suggestions are: 1. Mass distribution of HCB, 2. Take full Use of HCB by preparing compost, 3. Price of the bin should be reduced, 4. Provision of distributing large bins, 5. Provision of bin stands, 6. Bin handle should be attached, 7. Provision of compost marketing should be developed and 8. NS = No comments

Source: Household Survey, May 2005

General Suggestion on HCB

The suggested suggestion by the users is presented in Table 3.2-7. 55% of the users did not felt to suggest anything; they are satisfied with present condition but 37% of users did strong suggestion that distribution of bins should be further expanded and made available who are interested in home composting and other users (9%) suggested other suggestions as take full use of HCB by preparing compost, price of the bin should be reduced, provision of distributing large bins, provision of bin stands, provision for bin handle and provision of compost marketing.

3.3 Findings of Key Informant Survey

3.3.1 Home Composting Training

The total number of training program, number of participants in training program and numbers of HCBs distributed by respective agencies is summarized in Table 3.3-1. The SOUP, WEPCO, CDS/LSMC and KRM were the agencies that gave training on home composting in Home Composting Bin. In total, 1,317 of participants were trained in 40 groups and total number of HCBs distributed was 1,137 bins**.** The SOUP has given training to 24 groups, 18 groups in KMC (ward 21) and 6 groups in LSMC (wards 12 & 18) imparting training to 761 participants (502 participants in KMC and 259 participants in LSMC), and distributed 670 HCBs. In the same way, WEPCO has provided home composting training to 6 groups (236 participants) and distributed 200 HCBs. The CDS/LSMC gave training to 204 participants in 6 groups and distributed 216 HCBs. Similarly; KRM organized home composting training to 4 groups, where 116 trainees were trained.

Table 3.3-1 Home Composting Training given by Agencies

(Unit: %)

Name of Organization Involved in Home Composting Activities	Metro City/ Municipality	Ward Nos.	No. of Groups and Total Participants in Training Program 2005/06		HCB Distributed	HCBs Used for Composting
			Groups	No.	No.	No.
SOUP	KMC	21	18	502	499	499
WEPCO	LSMC	1 & 2	6	236	200	200
CDS/LSMC	LSMC	5, 7 & 8	6	204	216	216
SOUP	LSMC	12 and 18	6	259	171	171
KRM	KRM	1, 5 & 14	4	116	51	51
Total			40	1317	1137	1137

Source: Key Informant Survey, May 2005

3.3.2 Waste Source for Home Composting in HCB

Waste Source for Home Composting

As information gathered from the agencies the home wastes are the main source of waste for composting. The source of compost materials used for composting are presented in Table 3.3-2. As shown in the table all bin users are using home waste for composting.

Table 3.3-2 Waste Material Source for Home Composting

(Unit: %)

	Materials Source for Composting			Distrib. Size	Appro. Size	Effectiveness of HCB			Compost Making Duration (Months)			Placement of HCB			
Name	HW	FW	Both	100lts	100lts	Good	Ave.	NG	< 2	2 to 3	> 3	1	2	3	4
SOUP	20			20	20	20				20		6	6	0	6
WEPCO	20			20	20		20			20		6	0	6	6
CDS/LSMC	20			20	20	20				20		6	6	6	6
SOUP	20			20	20	20				20		6	6	0	6
KRM	20			20	20	20				20		6	0	6	6
All Total	100	0	0	100	100	80	20	0	0	100	0	31	19	19	31

Note: 1. HW = Home waste, FW = Farm waste, Both = Use of both waste.
2. Bin Placement : 1. Top roof, Groub floor, 3. Near kitchen, and 4. Backyard/Veranda

Source: Key Informant Survey, May 2005

Distributed Bin Size and Effectiveness of HCB in Compost Production

All the distributed size of HCBs was of 100 liters size and all the agencies have suggested given size as appropriate size. 80% of bin users have appreciated the effectiveness of bin as positive and few of them (20%) suggested it effectiveness as average but none of agency commented against.

Compost Preparation Duration and Bin Placement

All the agencies have experienced same idea about duration of compost preparation. All the agencies reported that compost has been prepared in 2 to 3 months depending on types of inoculums used. The composting time and placement of HCBs is presented in Table 3.3-2. As indicated by the table, 31% & 31% of agencies reported that bins are placed in top roof and Veranda and others reported as placed in ground floor (19%) and others kept bin near by kitchen (19%). Compost quality and compost preparation time is affected by so many factors but placement site of bin is one of the factors because if it is placed in dark or closed place showers the decomposition.

3.3.3 Structure of HCB, Aeration and Temperature Situation of HCB Shape and Size of HCB

Questions were asked to the associated agencies about shape, size and holes provided in bins. All the respondents reported that size of distributed bins are of appropriate size and 60% of respondents supported present shape of bin others not and suggested round shape (Table 3.3-3). All the agencies felt that holes provided for aeration to the compost bin is more than necessary and suggested it would be better if be half in numbers.

Aeration Situation in HCB

The way holes are provided in bins; some has reported much more holes are made than necessary. 60% of respondents has reported that the holes provided for aeration is good and satisfactory and others reported (40%) that much more holes are provided than necessary (Table 3.3-3).

Temperature Situation in HCB

80% of the agencies reported that temperature gain in HCBs is satisfactory and rest 20% expressed their doubt saying that heat is lost because of many holes in the bins (Table 3.3-3).

Table 3.3-3 Structure of HCB, Aeration and Temperature Situation of HCB

(Unit: %)

Name	Question related to HCB			Aeration in HCB			Temperature in HCB			
	Size Ok	Shape Ok	Holes Not OK	1	2	3	1	2	3	4
SOUP	20		20	20			20			
WEPCO	20	20	20	20				20	0	
CDS/LSMC	20	20	20		20		20			
SOUP	20		20		20		20			
KRM	20	20	20		20		20			
All Total	100	60	100	40	60	0	80	20	0	0

Note: 1. Aeration: 1. Higher than necessary, 2. OK and 3. Low
2. Temperature: 1. Satisfactory, 2. Heat loss 3. Compartment system cause heat loss; and 4. Others
Source: Key Informant Survey, May 2005

3.3.4 Improvement in HCB

Some questions were asked to associated agencies inquiring that modifications are needed or not in present bin structure. 60% of respondents said that certain modifications are required in bin. None of the agency did not asked modification in bin size, color, compartment system, door, aeration system but some complained on shape of bin, much more holes in bin and temperature loss in bin due to many holes in the bin.

Table 3.3-4 Improvement in HCB

(Unit: %)

Name	Imp. Needed in HCB		Improvement needed in HCB (structure)							
	Yes	No	Size Ok	Shape Ok	Hole Ok	Color Ok	Compart. Ok	Door Ok	Aeration Ok	Temp Ok
SOUP	20		20			20	20	20	20	
WEPCO		20	20	20	20	20	20	20	20	20
CDS/LSMC		20	20	20	20	20	20	20	20	20
SOUP	20		20			20	20	20	20	
KRM	20		20	20		20	20	20	20	20
All Total	60	40	100	60	40	100	100	100	100	60

Source: Key Informant Survey, May 2005

3.3.5 Use of Inoculums for Home Composting

As reported by agencies, households using inoculums for home composting and types of inoculums used by households is given in Table 3.3-5. As shown in the table, all households (100%) are using different types of inoculums to accelerate composting activities faster and for quality compost production. The different types of inoculums used by the households were EM (Effective Microorganisms), Bokasi (made from EM), topsoil (surface soil), compost (old compost) and ash. 26% and 26% of households are using inoculums EM and top soil and others have used Bokasi (21%), compost (21%) and ash (5%). Ash itself is not an inoculums but it helps to create congenial environment to microbes.

Table 3.3-5 Inoculums Used for Compost Decomposition

(Unit: %)

Name	Use Inoculums		Inoculums Used				
	Yes	No	EM	Bokasi	Compost	Top Soil	Ash
SOUP	20		5	5	5	5	
WEPCO	20		5	5	5	5	
CDS/LSMC	20		5	5		5	5
SOUP	20		5	5	5	5	
KRM	20		5		5	5	
Total	100	0	26	21	21	26	5

Source: Key Informant Survey, May 2005

3.3.6 Use of Compost and Purpose of Home Composting

Use of Compost

Just to know the purpose of home composting a question was inserted in the key informant. As suggested by agency, some of the households have given more than one answers saying some households might have double purposes. The response of households to this question is presented in the Table 3.3-6**.** Almost all bin users (100%) answered to that question saying that home composting is done to manure flowers (manure to flowers either in garden or pot) and 40% of them are also using in crop production.

Purpose of Home Composting

As suggested by agency, some of the households have given more than one answers saying some households might have double purposes. As information gathered by agency, 80% agency said that purpose of composting was to reduce pollution or improve home environment, 60% expressed that they are used in flower (manure to flowers), 40% claimed as they have used for crop production and 40% reported as waste management but no agency reported for income generation (Table 3.3-6).

Table 3.3-6 Use of Compost and Purpose of Home Composting

(Unit: %)

Name	Compost Use			Purpose of Compost Production				
	Garden	Agri.	Others	Income Gene.	Reduce Pollution	Crop Prod..	Flower	Waste Mang.
SOUP	20				20			20
WEPCO	20				20		20	
CDS/LSMC	20	20				20	20	
SOUP	20				20			20
KRM	20	20			20	20	20	
Total	100	40	0	0	80	40	60	40

Source: Key Informant Survey, May 2005

3.3.7 Problems of Composting and Sustainability of Home Composting

Problems of Home Composting

As information collected from key informant survey, 60% reported no problem in home composting in HCB, but others (20%) reported leachate problems and other 20% reported insect problems. These problems were minimized in later stage, when bin users became experienced in home composting.

Sustainability of Home Composting

The associated agencies with home composting business are not so sure of the sustainability of home composting but they expressed based on their experiences that home composting might last longer. If the marketing aspect of home compost could be well linked or well organized with compost buyers home composting will sustain longer.

Table 3.3-7 Problems of Composting and Sustainability of Home Composting

(Unit:%)

Name	Problems to Prepare Compost in HCB		Sustainability of HCB		
	Leachate	Insects	No Problems	Go for Longer	Marketing
SOUP					20
WEPCO	20	20		20	
CDS/LSMC			20	20	
SOUP			20		20
KRM			20	20	
Total	20	20	60	60	40

Source: Key Informant Survey, May 2005

3.4 Training and Monitoring Plan for Home Composting

In order to continue the composting activities by HCB, monitoring and follow-up the activities is required whether the bins are properly used or not and how is the performance of bins in home composting. For the effective and efficient use of HCBs, two cycles "Monitoring Plan" is proposed. The cycle gives details about monitoring days and refresher training schedule. The first cycle monitoring is meant for close monitoring and the second cycle for the follow-up monitoring. The training and monitoring activities for home-composting activities for cycle one and cycle two is presented below.

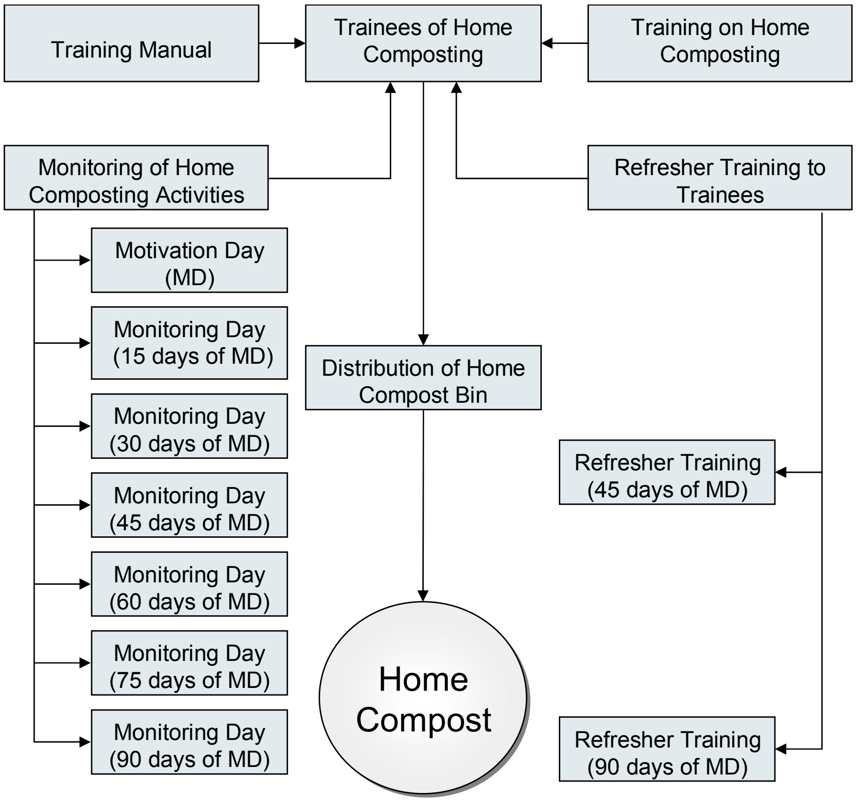


Figure 3.5-1 Training and Monitoring Plan for Home Composting (First Cycle)

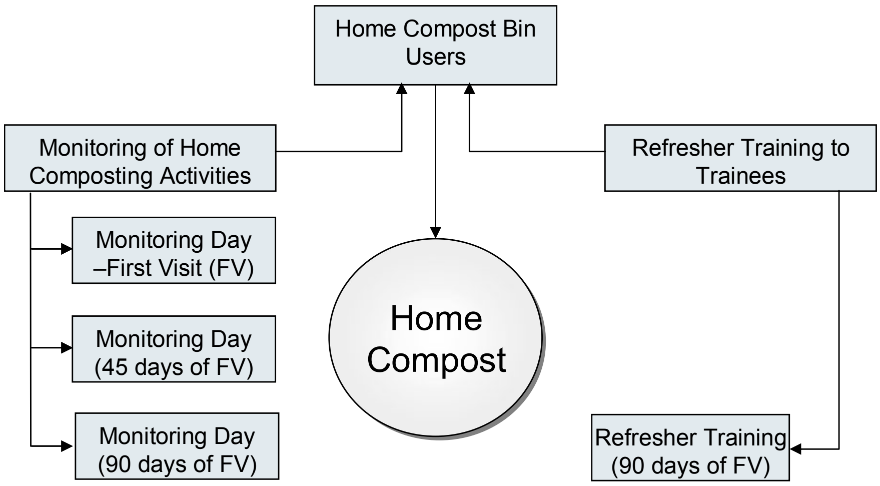


Figure 3.5-2 Training and Monitoring Plan for Home Composting (Second Cycle)

CHAPTER 4 CONCLUSIONS

4.1 Conclusions

- The Home Compost Bin (HCB) distributed under the pilot project regarding waste minimization has been performing well.
- The home compost is prepared within three months in home compost bin and in some case it prepared within two and two and half month.
- The compost produced in HCBs is well decomposed and physically looks good giving dark brown color and no bad odor.
- The compost produced from Home Compost Bin has contained good proportion of nutrients.
- The overall average result of samples are given pH as 7.7, moisture content of compost as 40.0%, Organic Matter 11.9%, Nitrogen as 1.13%, P_2O_5 as 0.70%, K_2O as 3.49%, Electrical Conductivity as 1.33 (mmhos/cm) and C:N ratio as 6.7. The nutrient contents compost produced in HCBs are within the range or higher than any other average compost.
- The compost produced from HCB found better than farmers' compost and SW-C produced at BKM.
- The households are happy and they expressed their appreciation having HCBs with them. Now, they have not to go every morning with a bag of waste to the container to throw the waste.
- Besides, they are converting home waste to compost, which are being used in garden (to manure flowers) and some have used in field, mainly in chili bed, paddy seedbed and some has used maize field.
- Mostly all bin users have received training on home composting and most of the users are literate (87%), can read manual "How to Use Home Compost Bin".
- In the beginning of operation of HCBs some problems of insect and leachate were experienced but it was minimized by improving in waste filling technique and prevention taken against the problems.
- The main purpose of home composting is to reduce home pollution, waste minimization and manure to flower and field crops but no one said for income generation.
- Almost 50% of the users of HCB expressed their desire to promote this activity and distribute such bins to interested persons.

4.2 Recommendations

- There is not such great improvement is needed in design and structure but some improvement are suggested that has to be rectified as strong bin door (it is week and rats enter in bin and edge of door has to be rounded), better fitting of compartmental iron frame (week and not adjusted well in its position) and nominal hole numbers in bins (many holes which loss energy or heat). Also, handles should be attached to bin so that it could be handled or transferred as per need and as when needed.
- Some of the users have requested larger size of bins so some larger bins have to be manufacture and distributed but its demand is not so large.

Pilot Project B-5

Training Manual for Trainers on Home Composting

Table of Contents

Training Manual for Trainers on Home Composting

His Majesty's Government of Nepal, Ministry of Local Development and JICA jointly working in a "Clean Kathmandu Valley Study" towards minimizing waste at source by the use of organic waste into compost. The program has been launched in some community as the Pilot Project on waste minimization in Kathmandu Metropolitan City, Lalitpur Sub-Metropolitan City, Bhaktapur Municiplaity, Madhaypur Thimi Municipality and Kirtipur Municipality. A suitable Home Compost Bin (HCB) has been designed for home composting in bin from home waste materials. The bins will be distributed to the households of the targeted community. Along with the bin, a manual on "How to Use Home Compost Bin" will also be provided to the bin users. Training programs will be organized to all bin users of the community on "Home Composting in Bin" to make the program more effective.

A training manual on "Training Manuals for Trainers for Home Composting in Compost Bin" for trainers has been prepared in order to make the training subject matters uniform across all five municipalities because the trainers of municipality or private agencies could organize the training. The manual consists of 12 topics (classes), the trainers will consider following points during training.

- Objectives, method of instructions, time duration, required materials; activities and conclusion have been specified for each subject.
- The whole training program has been designed for approximately 6 hours. Therefore, it can be one-day training program. However, depending on the trainees' understanding/grasping ability and time taken for formal program as inauguration/closing ceremonies etc, the training program can be held for two-days, if required.
- As a way to introduce participants to each other, three methods have been presented in this manual. The trainer should choose suitable one method and execut.
- In order to make the training session participatory and lively, the trainers should let the participants take a short break of 5-10 minutes after each training class for drinking water, using the restroom etc and the break time can also be utilized for playing games or to let participants show their talent.
- The trainer or coordinators should make all the arrangements of the required materials for training training beforehand.
- To make the trainings more participatory, various methods of interaction among the participants and other methods of participation as written work, brain storming, displaying information, team work activities, practical exercises and verbal explanations have been adopted in the training.
- The trainer should encourage all participants to actively participate in all activities or discussions during the training.

1. Introduction

a) Objective: **To introduce the participants to each other and to draw attention towards the subject matter.**

Method: Pairing up through pair words and introduction

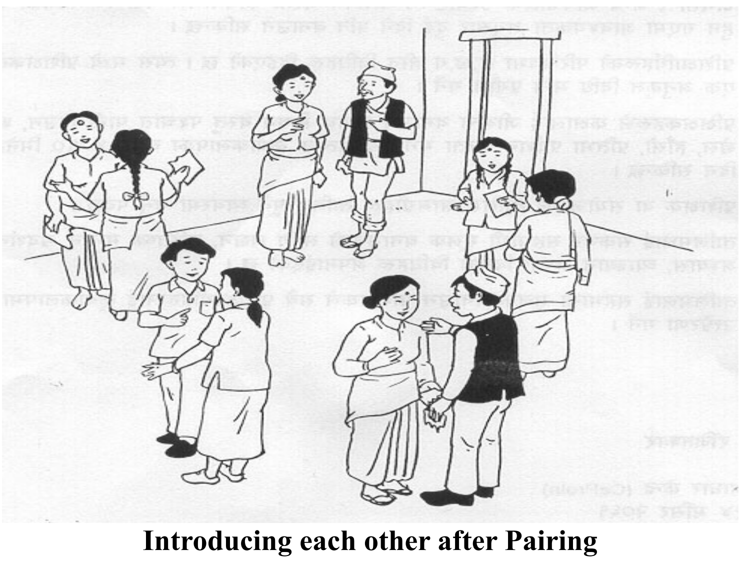
Time: 30 minutes

Materials Required: Paper cut into small pieces enough for participants, write down one part of pair word

Pair examples- 1) Black dust/Chak dust, 2) Home waste/Compost, 3) Bokashi/ Jodan, 4) Compost making container/ Compost Bin, 5) Waste/Money, 6) Pieces of plastic/ Plastic bucket, 7) Waste wollection/ Plastic bucket, 8) Lets be clean/Lets be civilized, 9) Minimize Waste/ Make Compost, 10) Good Compost/Good Plants.

Activities:

- Write down the words of pairs (one word in one paper) in the papers from related pair of words and fold and put in a box and mis them all well. Let each participant draw only one folded piece of paper.
- Ask each participant to look for a partner who has a related word to the one has.
- Let the pairs find each other partner and introduce to each other.
- The introduction could include name, address, profession, qualifications, hobby, number of family members etc.
- Ask each of the pairs to introduce their partners. Introduction should include above-mentioned information.
- Before the pairs introduce themselves, ask each of the participant pairs that the reason why they thought they were pairs on the context of solid waste.



Introducing each other after Pairing

b) Method: Pairing up through cut piece of drawing

Time: 30 minutes

Materials: Waste management related pictures/drawings:

Required: For example- 1) A pile of waste, 2) A picture showing a person throwing waste into a container, 3) Compost bin, 4) A picture showing waste seperation, 5) A picture showing a person collecting compost, 6) A person putting compost in flower pots, 7) A picture showing plant with compost and without compost, 8) Cyclic diagram of organic waste management, 9) Untidy communities, and 10) Tidy communities.

Activities:

- Cut the pictures into different curvature and make two parts of each photo/drawing. Fold the pieces and put them in a container. Let each participant take out one piece.
- Let each participant find a partner matching the photograph.
- Ask each pair of participant to introduce to each other.
- Let all participants introduce their partner. Introduction could include same as above.
- Before starting the introductions, ask each participant to give short notes that what are the messages given by the photograph.

c) Method: Introducing a partner

Time: 15 minutes

Materials: Solid waste management related sentences

Required: For example- Pollution, Organic Waste, Inorganic Waste, Compost, Reuse, Recycle, Scravenger, etc)

Activities:

- If the participants are from the same community or if there is shortage of time, participants can introduce themselves with their name, address, profession, education, number of family members, hobby etc.
- In order to assess the participants' understanding on solid waste, ask to explain the meaning of terms related to waste as - organic waste, inorganic waste, compost, reuse, recycle, scravenger, khate etc.
- Other methods can also be used depending upon available time and understanding/grasping capacity of participants.

2. Setting Objective of Training

Objective:	To set the objective of training
Method:	Writing
Time:	15 minutes
Materials Required:	Meta card, marker pens, chart paper

The training is designed to teach participants how to make compost; even then participants might not be aware of that what they are going to learn in training. Therefore, it is important to make clear the objective of the training and to make them communicated their expectations of the training.

Activities:

- Provide a colored metacard to each of the participants.
- Ask the participants to write down two things they wish to learn from the training.
- Collect the cards and put all similar contents in one line and other topics in other line on the board.
- Doing so, participants will be clear that what they are going to learn in the training.
- If there are some participants who cannot read or write, the trainer should write writing their saying or view on a chart paper.
- After the training, participants should be asked to carry out evaluation on whether the participants' expectations had been met or not in the training.

Arranging Card of Similar Contents

3. Classification of Waste

Objective: To familiarize the participants to various types of household wastes.

Method: Brainstorming

Time: 30 minutes

Materials Required: A pile of household wastes

Activities:

- Place a pile of different kinds of household waste before participants..
- Ask two volunteers to come forward to help the training activities. Ask one of them to separate organic waste and the other to separate inorganic waste.
- Ask six trainees to come forward and ask to separate papers, plastic, glass, metal, rubber and cloth (one to each) from inorganic lot.
- Ask a trainee to explain about home waste, types of home waste and name the types waste produced in households.
- After hearing from the trainees, the trainer should define/ present a conclusive remark on household waste.

Conclusion:

We bring various materials in home like food, clothing, furniture, medicine, decorative items etc. With those materials some waste materials are entered in house without our notice. For example, biscuits, instant noodles, candy covers, medicine bottles, paper packaging, peels/seeds of fruits, vegetable parts as root, shoot and straw etc. We consume some products and discard or throw waste materials. These all unsable waste produced in the houses is called household waste. Household waste constitutes mostly of food materials, vegetables, fruit parts, plants and flowers, and in some quantity of plastic, papers, broken glass pieces, metal, rubber, cloth etc.

4. Waste Separation at Source

Objective:	To promote separation of waste at source in a bucket/ bag
Method:	Practice (Using two containers)
Time:	30 minutes
Materials Required:	A plastic bucket and a cloth bag

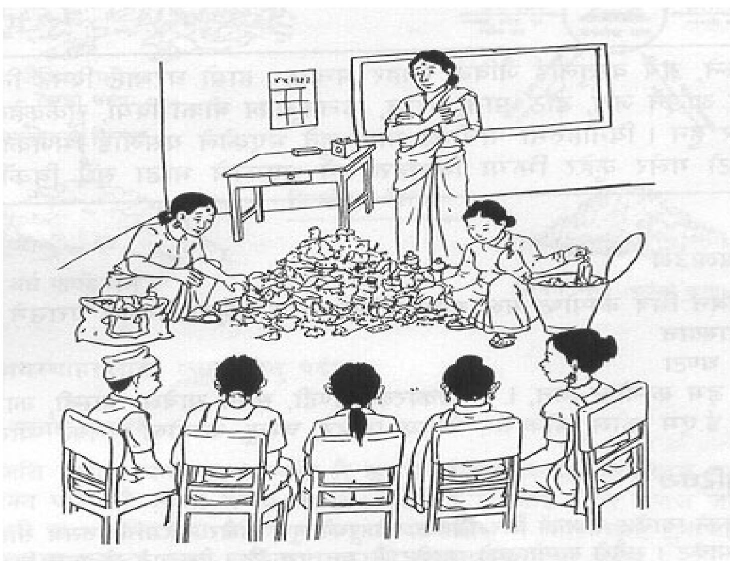
Activities:

- Ask two participants to come forward and ask to one participant to put all organic waste in a plastic bucket and other put all inorganic waste in a cloth bag.
- Provide some amount of waste to each participant and let each participant practice separating the waste and put in respective containers.
- The trainer should put forth a concluding remark at the end of the session regarding the waste separation at the source and its benefit.

Conclusion:

Two containers need to be arranged for waste collection at home - a plastic container with a lid and the other cotton bag. Moist wastes contain high level of water and therefore collected in a bucket. Dry materials as paper, plastic, glass, metal, rubber etc can be collected in a cotton bag. As the waste is generated in house colleting the moist waste in the bucket and dry waste in the cloth bag. Thus, to separate waste at the generation point and put in the defined container is called separation at the source. The benefit of waste separation at source are given below:

- Dry waste would not mix with moist waste.
- No tension of separating waste again for composting.
- Recycle materials will be dry and clean.
- A culture of solid waste management practice will be established.



Waste Materials Separation Practice

5. Introduction to Organic Waste

Objective: To make participants knowledgeable on organic wastes generated at homes

Method: Demonstration of Waste

Time Required: 15 minutes

Materials Required: A pile of organic waste

Activities:

- Place piles of various kinds of organic wastes.
- The trainer should pick one by one item from the piles and let the participants name them.
- The trainer should put a concluding remark.

Conclusion:

Those matters that under go decomposition and fermentation processes are called organic waste. The wastes generated in households like waste food, vegetable parts like roots, stem, leaves, straw, fruit skin and seeds, dried flowers and plants etc are all organic wastes. The organic waste is also called as wet waste because of high moisture content. Insects will be generated in the waste in the process of decaying of organic waste therefore; the bin should be always kept covered.

Organic Waste

6. Compost Preparation Method

Objective: To familiarize the processes involved in composting

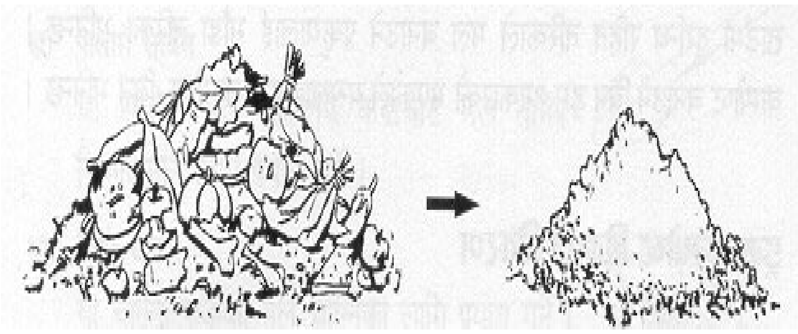
Method: Discussion/Explanation

Time Required: 1 hour

Materials Required: Compost bin, L- shaped rod, small shovel, sieve, card board/ magazine paper, soil, EM solution, Bokashi, compost, organic waste materials and knife

Introduction to Compost

Put a packet of compost one side and a pile of organic waste in other side and ask the preference of participants among the two. It is likely that almost all the participants will choose the packet of organic compost because it can be used for plants. Everyone should agree that the useful compost was prepared from the unpreferred organic waste materials, which was discarded by all. But why we cannot use that waste? Because the waste is not decomposed. The undecomposed waste materials cannot give nutrients to the plants and it will take some more months to decompose and to release nutrients to plants. If undecomposed materials are used in field, plants will not get plant nutrients and on above plants would suffer from insects and disease incidences. Therefore, organic waste is undecomposed material and compost is the decomposed product, from which plants receive organic matter and plant nutrients and in addition it helps to soil microbes to release soil nutrients to plants and further it reduces pollution and incidences of insects and diseases that created by unmanaged waste.

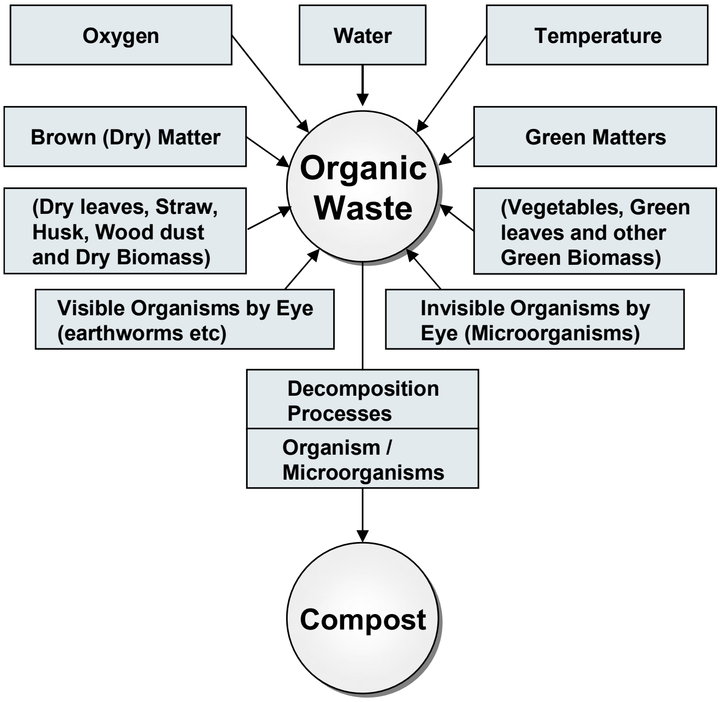


Organic Waste **Compost**

Processes Involved in Composting

Compost is the product of natural process of decomposotion of organic waste. In process of decomposition the organic waste starts to decompose and convert the waste materials into dark brown product and friable as soil that is called compost.

Schematic Diagram of Aerobic Decomposition Processes of Organic Waste



Good compost or faster decomposition of waste materials means giving congenial environments for decomposition. To enhance the decomposition process an optimum environment and conditions should be provided to microbes. In absence of congenial environement to mocrobes, waste will take longer time for compost formation and quality compost will not be prepared.

Optimum Conditions for Compost Preparation:

a) Cutting the Organic Waste into Small Pieces

As the wastes are of larger in size and hard, it will be difficult for decomposition to microbes. In the result, it will take longer time for decomposition. Therefore, it is important to cut organic matter into small sizes of about one to two inches. Organic waste should be cut into small sizes before putting them into bin. As the size of waste materials become smaller and smaller better and earlier the decomposition of waste materials.

b) Balancing the Dry Matter (Brown Matter) and Green Matter

Both brown matter and green matter are mixed in organic wastes. Brown matter likely contains high Carbon. Brown matters like saw dust, straw, dried leaves etc contain high Carbon. Carbon provides energy to the microorganisms. Green matters provide higher proportion of Nitrogen. Green matters like vegetables, grass, cow dung etc contains higher proportions of Nitrogen. Nitrogen provides nutrients to the microorganisms. Therefore, proportion of brown matters and green matters is important in composting but as we consider our waste contains both matters in good proportion and they supplies balance food to microbes, eventhen we have to give due attention that whether both matters are proportionately mixed up or not.

c) Temperature Management

Microorganisms become inactive in low temperatures. As a result the decomposition processes are lenghthen. Therefore, if the temperature drops down inside bin some urea and old compost can be added to fasten the process of decomposition.

d) Air Circulation

Microorganisms require oxygen in decomposition process. Therefore, there should be good air circulation provision for composting. Air holes are provided in compost bin in order to ensure a good airflow.

e) Moisture Management in Compost Matters

Microorganisms become inactive both in dry conditions and very moist conditions. Therefore, the moisture content of biomass should be in optimum condition. We say right or optimum condition, when waste taken in palm the organic matter should look moist but palm should not get wet.

f) Use of Inoculums (Jodan)

To activate the decomposition process certain microorganisms are required, those microbes are called inoculums (Jadan). Curd can be made from milk without mixing curd (inoculums) but milk could be fermented quicker if some curd (inoculums) is mixed in milk. Similarly, inoculums are needed for comosting in order to fasten the decomposition process. The inculums are abuandantly found in topsoil (surface soil) of cropland, compost and EM (Effective Microorganisms). Therefore, these materials are used as inoculum source. Any of the above inoculums help to fastem decomposition for composting.

7. Compost Preparation Methods in Compost Bin

Objective:	To teach making compost from organic Waste in compost bin
Method:	Demonstration
Time:	1 hour
Materials Required:	Compost Bin and tools of bin, organic waste, knife, Inoculums, water.

Preparations Required:

The participants should sit in a circle so that every one can observe the demonstration.

Objective of Producing Compost

- To use the waste materials into productive purpose by transforming of waste materials into compost.
- To supplement plant requirement of organic mater and other plant nutrients.
- To transform home wastes into compost and reduce pollution.
- To reduce daily generated wastes in the city at the source by minimizing the wastes.

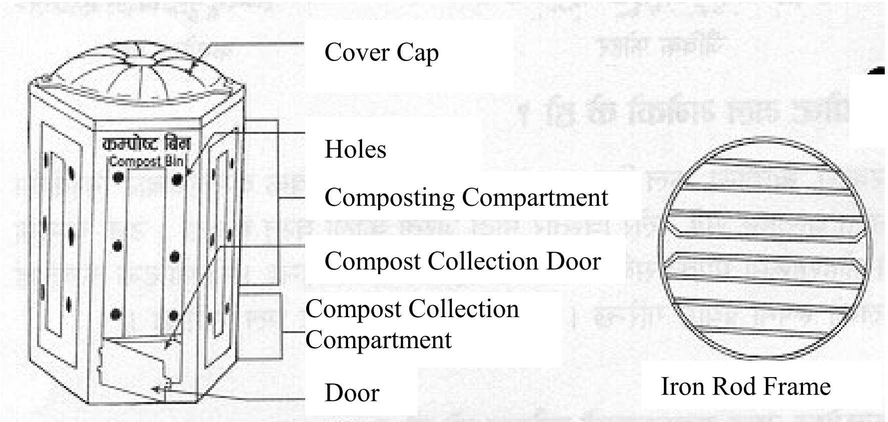
How to Prepare Compost in Bin or Home Composting Bin?

Compost can be prepared in a very simple and environment friendly way in a bin at the corner of house. The bin method of composting is process of collecting waste in a bin by adopting composting technology and making compost in a shorter time without any bad odor in a corner of house is called Bin (Bhanda) Composting or Composting in Bin. The composting bin is like a drum so it is called "Drum Compost Bin" but now it is commonly said "Compost-Bin" instead of "Drum-Compost-Bin".

Sketch and Description of Compost Bin

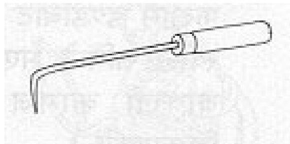
Bin is made up of green thick plastic. It is 19 inches in diameter with 24 inches height and hexagonal in shape. Upper side of bin has an open space and a cover cap is attached. The cap can be open or closed as per need. The bin is internally divided into two parts by iron made frame as upper larger part and lower small part. The iron frame is made with iron rod placing in 2 and 2 inches apart as shown in figure. The upper large portion is called as compost-making compartment and the lower small one is called as compost-collecting compartment. In the compost-collecting compartment there is a small door with door cover, which can be opened and closed as needed. Many small holes are provided in the upper portion (composting compartment) of bin. These holes are helpful for air circulation or air movement in the bin.

Sketch and Description of Compost Bin



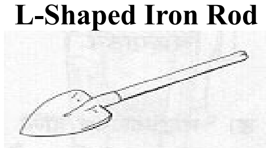
Tools Accompanied with the Bin

a. **A L-shaped Iron Rod:** If compost did not fall down due to compaction, then this tool can be used to pull out the compost.



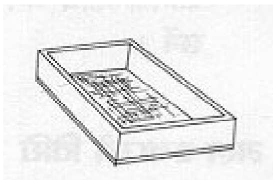
L-Shaped Iron Rod

b. **Small Shovel:** This is a tool is used to collect the scraped compost from compost collecting compartment.



Shovel

c. **Small Sieve:** This tool is used for sieving the compost and large not decomposed waste materials are separated out.



Sieve

Pre-preparations for Compost Making

The following pre-preparation arrangements are required for compost making:

a) **Site Selection for Compost Bin:** Suitable and comfortable site should be selected for compost bin before making compost. As the bin can be placed inside the house or outside but it is better to have protection from direct sun light or rain water. If outside the house, the bin can be placed backyard of the house or a corner of garden or a shed area. If inside the house, the bin can be placed near kitchen room or in the top roof of the house or in ground floor or in Veranda/Balcony.

Platform

b) **Preparation of Platform for Bin:**
After selecting place for bin, manage a 6 inches height platform of available materials and manage for bin placement.

Bin Placement

c) **Bin Placement**
The bin should be placed on the platform and it should be arranged in such a way that the door of compost bin should face well for easy collection of the compost and bin should be arranged in non moving position.

Placement of Iron Frame

d) **Fixation of Iron Frame in Bin:** Iron frame should be kept in bin where its position is provided in the bin.

e) **Paper Layers Over the Iron Frame:** Put three or four fold of newspapers or papers on the iron rod frame so as to protect waste from falling down.

Layer of Soil

f) **Put a Layer of Soil:** Put about an inch layer of soil (surface soil or garden soil) above the paper. Now, bin is ready for compost preparation. Cut waste materials can be transferred in the bin for compost preparation.

Method of Compost Making

a. **Collection of Organic Waste:** Manage a bucket having lid to collect the organic waste. Collect the home organic waste and cut them into small pieces (1 to 2 inch pieces) and put in the bucket. Transfer the chopped waste in the bin and remain closed the bucket all the time. Thereafter, go on collecting wastes in the same bin.

b. **Transferring the Waste in the Bin:** Put the collected waste in the bin once a day either in morning or in evening. Check the waste materials that whether the wastes are cut into pieces or not and if some are left unchopped, do pieces and pour in bin.

Chopping of Waste Materials

c. **Surface Leveling inside the Bin:** After putting the waste inside the bin, the surface of waste heap should be leveled by small shovel so that it could not be heaped in a place or corner. This will result uniform distribution of air, moisture and inoculums in the waste.

d. **Spraying or Mixing of Inoculums:** Spray approximately one tea glass of EM (active liquid) or some Bokasi powder or available surface soil (top soil) or compost over the waste. The lid of bin has to be immediately closed and should be remained closed. If the compost production rate has reduced due to poor decomposition, then spray the EM once or twice a week for better decomposition. The large pieces of undecomposed waste can be reused as inoculums by mixing over waste or putting back in the bin which was unsieved during sieving compost for sale or own use.

Transferring Waste in Bin

e. **Regularly Put the Waste in Bin:** Have regular practice of putting waste in the bin and if the wastes are too moist or waste includes only fresh vegetables it will be better to wither them in shade and pour in the bin.

Using Inoculums

f. **Put other Waste Materials:** Other waste like ash, poultry manure and animal manure can also be put in the bin to make compost. If these things could be well mixed with waste and put into the bin, it will be good inoculums and will help to decompose waste faster.

h. **Add Water to keep Waste Moist:** Spread or Sprinkle water over waste materials inside the bin, to maintain certain moisture content in the waste. In high moisture condition anaerobic decomposition will be initiated, which will result leachate problems and give bad odor, so give water just to moist waste materials.

Adding Waste

i. **Time Taken for Compost Decomposition:** In general, compost is prepared within three months but it can be prepared in two months if good inoculums could be used. Compost, Bokasi and EM are the good inoculums for composting.

How to Examine Whether Compost is Prepared or Not?

After 2 to 3 months it should be daily checked whether compost is prepared or not. Observe in the compost-collecting chamber of the bin whether compost has falling in it or not. If no compost found, then scrape inside the frame by the iron rod and pull out the compost. If the compost is not prepared then leave as it is for some more days. Waste like rice, fruits and vegetables etc takes 2 months to decompose but hard wastes like potato, cauliflower, radish or waste with hard peels etc takes more than 2 months.

Following qualities are observed in well decompose compost:

- Compost will be odorless or no bad odor smells out.
- Compost will be of dark brown in color and friable as soil.
- It would be difficult to identify the original waste because the wastes are already decomposed and converted to compost.

How to Collect Compost?

- If the compost is dry then it will start to fall down in the lower collection compartment of the bin. But if the compost is wet then compost will not fall down. In such condition we should pull out compost by by iron rod.
- The collected compost in compost-collecting compartment is taken out by shovel and then collected in a separate bucket. This compost can be immediately used in the field or in garden.
- To prepare compost for selling in the market, product should be dried on the paper or cloths in the shade but not in direct sun.
- If the compost is moist and make shade dry for some hours and make it powder with the help of a tool or small hammer.
- Then sieve the compost by provided sieve, now it can be used as compost or make charming package of one kg packet in polythene bag for sale.
- The unsieved waste things should be put back in bin. These wastes will work as inoculums.

Collecting Compost

Points to be considered while Making Compost

- The waste material should not be too moist or too saturated.
- Avoid water going to bin from bucket while pouring waste in the compost bin.
- If waste is moist or has excess moisture, put in the bin after withering the waste for a while.
- Regularly drain the excess water or leachate from compost-collecting compartment, if collected.
- Add some Bokasi, if bad odor smelled out and/or incidences of insects have increased.
- Egg's shell can be put in the bin but it has to be broken into fine pieces.
- If fresh waste (vegetables and fruits) has to be used as waste, it will be better to wither for few hours in shed and put in the bin.
- Composting materials should be organic waste and brown (dry matter) and green matter (fresh matter) should be in good proportion.
- There should be good air circulation inside the bin (in waste materials)
- Good inoculums should be used and it should be well mixed up with waste materials.
- The waste materials used for composting should be well chopped or cut into small pieces.

Advantages of Compost Bin

- Compost can be prepared in bin placing them either inside or outside of the house.
- As good air circulation is managed in bin, there is no problem of odor.
- As the shape of the bin is good, it does not give bad show even if placed in trans pass way.
- Compost can be available every time in the house because it has been prepared in house from own home waste materials.
- There will not be any problem of insects and flies because wastes are used for composting which are well decomposed.
- Pollution will be reduced with the good management of waste.

Advantages of Compost

- It helps to make soil porous and friable.
- It helps to improve air circulation and drainage of soil.
- It improves soil fertility by providing organic matter and plant nutrients to the plants.
- It provides food to soil microbes that help to provide soil nutrients into available forms to plants.
- It helps to improve physical, chemical and biological condition of soil and enhances water holding and nutrient holding capacity of soil.
- It helps to release soil nutrients slowly and steadily.
- It helps to reduce pollutions by transforming the waste into compost.
- It helps effective management of waste by transforming waste into compost.
- It does not give adverse effect to plants as by chemical fertilizer even if excessively used.

Use of Compost

- a). It can be used to seedling/sapling and plants of fruit crop, flower plants and vegetables.
- It can be used to vegetable seedbed for seedling production.
- It can be used in any crop for higher production.

How to Use Compost?

a) Before plantation of flower in flowerpot mix 1-2 handful of compost with the soil and fill up pot and plant the flower sapling.

b) At the flowering stage, spread 1-2 handful of compost around plant making a ring (ring placement) and incorporate well in soil.

c) Cultivation of field crop by applying compost in field. Generally, compost is applied at the time of land preparation.

d) To the planted plants of vegetable plants or fruit plants or flowers, spread 1-2 handful of compost around plant making a ring and incorporate well in soil.

Using Compost in Flower Pot

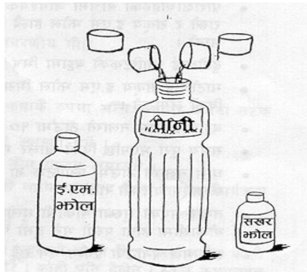
Application of Compost in Seedbed

8. Using EM (Effective Micro Organisms)

Objective:	Prepare activating EM Solution
Method:	By demonstration
Time:	15 Minutes
Materials Required:	A bottle of EM solution, Sugar Solution, water, 1 Liter Mineral Water Bottle

Introduction to EM:

EM is an Effective Micro-Organizationon which contains microorganisms like the bacterias and fungi that are not visible to our eyes. EM can be used as inoculums (Jodan). EM is brown in color and is available in the market.



Preparation of Active EM

Activities:

- Take a mineral water bottle and fill up it with water but not full.
- Using the mineral bottle cap (as measuring cup), add two cup of EM solution and two cup of unrefined sugar (Sakhar solution) into the bottle water.
- Stir the mixture well.
- The EM thus activated can be used immediately after preparation.
- The activated EM solution can be used within 1 - 2 weeks after preparation.

9. Using Bokashi

Objective:	To teach how to make Bokashi so that participants can prepare inoculums at home
Method:	Display
Time:	30 Minutes
Materials Required:	2 kilograms of rice husk (Dhuto), active EM solution, a plastic container with lid, soil, plastic sheet and plastic bag

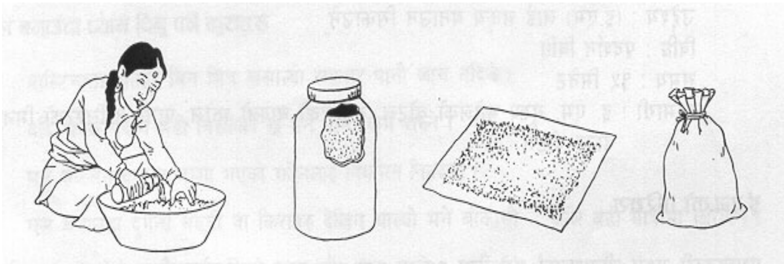
Introduction to Bokashi:

Active EM solution cannot be stored for prolonged periods. But, EM added to rice husk can be stored for long time. This powdered form of EM is called Bokashi.

Activities:

- Arrange all materials required in front of the participants. Add EM solution to a kilogram of rice husk and mix them well. The matter is said well prepared when the husk does not bind and becomes friable when it is tried to tighten in palm.

- Put the mixture in a container and try to compact it but do not totally fillup.
- Mix the active EM with soil and make soil paste and paste over the top of husk to make it airtight and keep tighten the cap of containiner.
- BPut the container in a cool and dry place for 10 to 15 days.
- After 10 to 15 days, take out soil by removing the cover of container. The matured Bokasi will smell like alcohol. Spread a plastic sheet or thin cloth sheet in shade place.
- Spread the Bokashi on a sheet of plastic or a piece of cloth and let it dry for one full day.
- The Bokasi can be stored after packaging the dry Bokasi in airtight plastic bags. The Bokasi may be spoiled by fungus growth if not air tighten.
- For frequent use, Bokashi can be separatly stored in a small container.



Mixing Husk | Filling in Container | Drying of Bokasi | Storing Bokasi

Bokasi Preparation

10. Practical Exercise To Participants For EM Solution and Bokasi Preparation

Objective: To let the participants practice on compost making, EM activation and Bokashi preparation

Method: Group Work

Time: 1 hour

Materials Required: Compost, EM solution, and materials required for preparing Bokashi

Activities:

Divide the participants into three groups and assign one group name by one of the following name.

a) Compost Making Group
b) EM Group
c) Bokashi Group

- Each group should select one group leader.
- The group should collect the required materials as per their assigned work.
- As instructed by trainer, each group should take turn to demonstrate their project activity before other groups.
- The group leader should explain the procedures and methodology of preparation of the assigned project.

- If group members or other group members find some mistakes/defaults in presentation ask to rectify mistakes or ask for better expalnation.
- The participants can put forwards their queries or suggestions if some one has.
- The trainer should encourage and motivate the group to answer the questions.
- If the participants find some problems in explaning the topics, the trainer should help to clarify.
- After the presentation, presentations should be ended with a round of applause.

11. Lessons Learned from Training

Objective:	To communicate messages in a creative manner to the participants
Method:	Story telling, Theatrical plays, Songs etc
Time Required:	15 minutes
Materials Required:	Story: The beauty of waste and a song related to environment

Activities:

- With the permission of participants within limited time, let the participants narrate the story or present it in the form of a dramatic play.
- After presentation of the story, discuss the lessons learned from the story.
- At the end of the training, let all participants sing the environment related song.
- Thank to all participants for their active participation in the training program, declare the closing of training program.

The Beauty of Waste

Two students were on their way to school. As they were entering the school gate, they heard sounds of crying and so they looked around to see who was crying. They could see no one except a pile of waste outside the school compound. Since the crying sound seemed to be coming from the piled up waste. Both went closer to the waste and listen carefully. It was indeed; the crying sound was comming from the pile of waste. How could they have imagined that even wastes cry?

Two Students: Who are you and why are you crying? come to us.

Pile of Waste: (Slowly raising its head and speaking in a sweet voice) I am the one who's crying, child. I could not dare so I am crying.

Two Students: But why? Has someone hurt you? Will you tell us, please? Can we help you?

Pile of Waste: Everyone hates me saying dirty one. They think I stink and I pollute so people throw me out on the streets haphazadly. People crush and walk over me and they close their noses with fingers when come closer to me. Pile of Waste started crying again. Students were sympathy with his condition and asked.

Two Students: How have you become so dirty? Can you not be neat and clean?

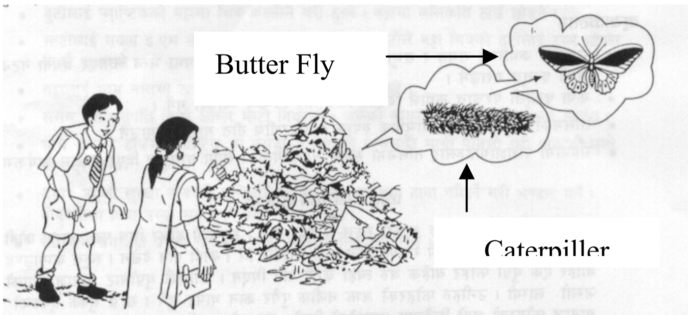
Pile of Waste: I am not dirty by nature. People could not recognize me and call me dirty. T hey mix me with all kinds of other waste and threw me wherever they wanted and made me dirty. I can prove that I am very helpful friend of people. I am good nutrients source for flowers, plants and vegetables and good source for vegetables and crops production. The form you are looking me is my undecomposed form. Compost can be prepared by decomposing me. Compost is the most important nutrient source for plant nurishment. I am that waste which can provide healthy environment by expanding grenery around. But people have not understood my worthness so they made me dirty mixing me together with other waste. It is not my fault it is they who made me dirty.

Two Students: We are really sad to hear the reality. Do please let us know how we can help you and how we can make you happy.

Pile of Waste: Thank you brother and sister for listening to my problems and offering help. There is no big problem to make me happy. I will explain very easy way. Take a Home Compost Bin and put organic waste in the bin every day after chopping into smaller pieces and within three to four months I will be transformed into good compost. When I will be compost and will be enriched with plant nutrients, I will look like dark brown friable like soil and without any stink. At that time I will be most lovely and likable one to the people. I will make the gardens; vegetable plot and fruit orchards beautifull and increase crop production. Therefore, people should not throw away things that are not useful to-day. If it looks usefull in future it has to be placed properly and safely. Is it not so, child?

Take an Example of Buterfly

Butterflies are colorful and pretty and so everyone likes them. We used to go forest to see buterfly. But no body likes caterpiller, which seems dirty and fraighten and cause hurt to body. If we start killing the caterpiller as we see them would we able to see butterflies in the future? Because the ugly looking caterpillars is the predecessor stage of butterflies. Therefore, the dirty caterpiller has ability to produce beautiful butterfly in future. Similarly, to-days' organic wastes have potential to trun into compost tomorrow, which has quality of good compost. If we start throwing organic waste to-day, there will be shortage of compost tomorrow, then plants will die due to lack of plant nutrients.



Life Cycle of Butterfly

Two Students: Listening carefully to the Pile of Waste and said, now we understand your concerns very well. Now onwards we will not throw organic waste instead we will use them to make compost. The two students took leave with the pile of waste with a promise that they would teach the method of bin composting to other people and went to school. They bought a compost bin the next day and starting putting organic waste produced in school into the bin. In three months' time, the compost was ready and was utilized in the school garden. That year, the school garden seemed the prettiest flowers ever. All the teachers of the school were extremely happy and thanked the two students for their initiative. From then onward, the street close to school compound was never littered and the school garden kept bearing beautiful flowers.

Tidy Environment of School

Conclusion:

Organic wastes are not useless things; they are very important resource for compost. Like the two students in the story above who utilized organic waste to make compost for their school garden, in the same way we also can make compost and promote making compost in our households, communities, schools, hotels, temples and offices and contribute towards keeping the environment clean.

12. Monitoring and Evaluation

Objective:	To solve the problems of participants and evaluate their work
Method:	Site visit
Visiting Date:	After 3 months
Manpower	Supervivor or Trainer

Activities:

The training organizer should arrange the monitoring and evaluation system of the trainees' houses in every week for few months to observe their activities regarding compost preparation and their impact in other houses or neighbours.