Introduction to Madhyapur Thimi Municipality (Nepal)

1. Information on the Project Area

1.1 Geographical Size of the project Area

Madhyapur Thimi Municipality (MTM) is one of the highest urbanizing towns. It is located in the district of Bhaktapur in Bagmati Zone, Central Development Region of Nepal. Madhyapur Thimi got its municipality status only in 1996 (B.S. 2053). Five Village Development Committees namely Bode, Chapacho, Balkumari, Dibyaswori and Nagadesh prior to this declaration were amalgamated to form this municipality.

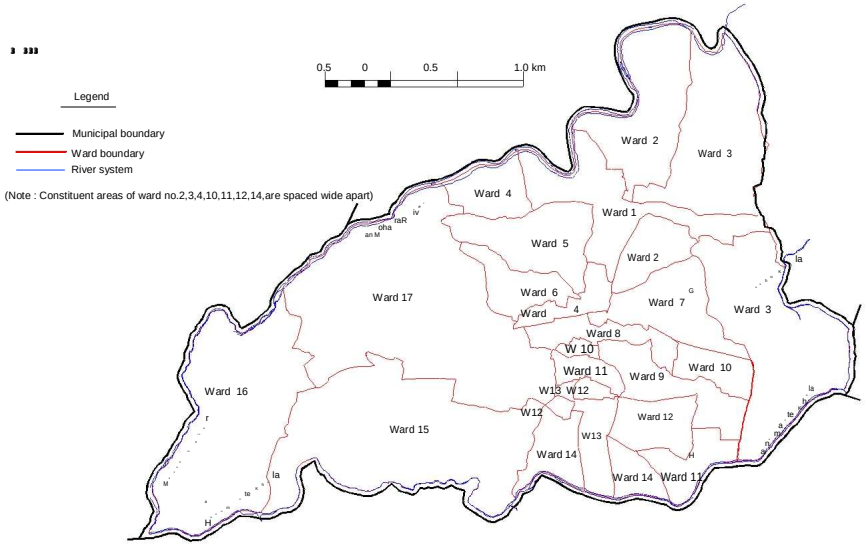

Figure 1: Map of Madhyapur Thimi Municipality

MTM has an altitude of 1,326 meters from sea level and is surrounded by Bhaktapur Municipality and Duwakot VDC in the east, Kathmandu Metropolitan City in the west, Mulpani and Gothatar VDCs in the northand Lalitpur and Balkot, Dadhikot VDCs in the south. It lies between $27^{o}40'0"$ and $27^{o}42'0"$ North latitude, and $81^{o}22'30"$ and $85^{o}25'0"$ East longitude.

The municipality has a land area of 11.453 sq. km. Primarily, Agriculture area is predominant consisting of about 78 percent of the land, residential area consist of 12 percent, industrial area 2 percent, Institutional and water bodies 5 percent and forest area consist of 3 percent.

The maximum and minimum temperature of the municipality lie between $35^{o}C$ and $1^{o}C$; and maximum and minimum rainfall are 409.1 mm and 6.3 mm per year.

Population as per the Census of 2001 was 47,751 (male 24,747 & female 23,004) with average household size of 5 (household number is 9,551 and population density of 4,298 per sq. km). The working age population (15-59) is around 65 percent with children (below 15 years of age) 28.5 percent and elderly (60+) 6.5 percent. The projection of population is 62,879 for the year 2008.

The municipality is predominantly inhibited by Newars (61%) and Chhetri, Brahmin and Tamang are other major casts.

1.2 Agriculture Farm Land

Out of the 39,564 population 10 years of age and above 21,790 (male 13,958 and female 7,832) have been found to be economically active. Out of the total 9,551 household, 3,675 households have Agricultural land only, 36 have livestock only, 52 have poultry only, 508 have land and livestock, 266 have land and poultry, 9 have livestock and Poultry, 151 have land livestock and poultry, and 4,854 have none of these all.

Table 1: Households with Agricultural Activities

	Household having							
Total	**Agriculture** land only	**Livestock** only	**Poultry** only	**Land and Livestock**	Land & Poultry	**Livestock & Poultry**	**Land Livestock & Poultry**	**Non of all**
9,551	3675	36	52	508	266	9	151	4,854

From this table, households with agricultural land are identified as follows:

Table 2: Households with Agricultural Land

S. No.	Description	Household Numbers
1	Agricultural land only	3,675
2	Land and Livestock	508
3	Land & Poultry	266
4	Land, Livestock & Poultry	151
	Total	4,600

1.3 Socio-economic Pattern

Literacy Status

Of the total population 6 years of age and over (43280) in Madhyapur Thimi municipality, 72.6 percent is literate. Male literacy is 82.7 percent and female 61.8 percent. Compared with national average, the total overall literacy is higher (national average 53.7 percent).

Educational Attainment

Among total literate population of 31,417 in the municipality, 28.8 percent has attained Primary education only, 18.1 percent Lower Secondary and 14.8 percent Secondary education. Literates with SLC constituted 11.4 percent. The proportion attaining higher education i.e., beyond SLC is 14.4 percent only.

Economic Situation

Table given under agriculture farm land presented the number of households by land used for agriculture purpose for the Municipality. It is interesting to see that the municipal households with land use for agriculture purpose are only 48 percent. Ward no. 15, 16 and 17 have very few land use for agriculture purpose which is only about 22 percent of the total households.

More than 65 percent of the households have no economic activity in the municipality. Only about 15 percent of the total households have adopted business and about 8 percent have services. Other activities are very less. Most of the business activities are concentrated in ward no. 1, 2, 3, 13, 15 and 16, where about 64 percent of the households are engaged in the business activities in this municipality.

Energy Situation

The situation of energy and infrastructures utilization and development in municipal area indicate state of environment and development. Environmental conservation is a common concern of all development efforts in municipal area.

The major sources of energy for cooking are firewood, kerosene and LP gas in most of the municipalities in Nepal. Besides, Biogas, Santhi (cow dung) and other sources of energy are also used for cooking in various places. Although there are many sources of energy of cooking, 59 percent households depend upon kerosene in Madhyapur Thimi municipality depend upon firewood for cooking. Besides kerosene, about 22 percent households depend on wood and about 17 percent on LP gas for the purpose of cooking. As given in Table below, energy sources are not stated for 80 households and 124 households use other than above mentioned sources of energy for cooking. About one third of the households in ward no 1, 2, 8, 9, 10, 11 and 14 use firewood for cooking. Kerosene is the important sources of cooking energy in all wards. However, LP gas is mostly used in ward no 15, 16 and 17 of the municipality.

Table 3: Number of Households by Type of Fuel Used for Cooking

Households by fuel usually used for cooking purpose								
Wards	**Total Household**	**Wood**	**Kerosene**	**LP Gas**	**Bio-gas**	**Santhi/ Guinths (Cow Dung)**	**Other**	**Not Stated**
Total	9551	2136	5618	1577	6	9	124	80
Percentage		**22.37**	**58.81**	**16.52**	**0.06**	**0.09**	**1.30**	**0.84**
1	441	142	274	23	1	0	1	0
2	358	129	199	23	0	0	6	1
3	476	177	213	16	0	0	68	2
4	339	52	271	9	0	0	4	3
5	345	140	181	17	0	0	1	6
6	288	84	196	6	0	0	1	1
7	510	68	357	84	1	0	0	0
8	431	142	263	21	0	2	2	1
9	278	117	144	8	0	0	9	0
10	380	164	189	21	0	0	1	5
11	407	158	224	12	0	0	0	13
12	388	132	220	24	0	0	8	4
13	620	99	446	52	0	0	22	1
14	434	192	211	29	0	2	0	0
15	1780	76	1026	654	0	1	0	23

16	1075	141	597	327	3	3	1	3
17	1002	124	607	252	1	1	0	17

Besides cooking, lighting is another important sector of energy utilization. The major sources of energy for the purpose for lighting especially in the municipal areas in Nepal are electricity and kerosene. As given in table below, about 98 percent households in Madhyapur Thimi municipality use electricity for lighting. Only 1 percent households use kerosene. Energy sources are not stated of 87 (0.91%) households. Most of the households in all wards use electricity.

Table 4: Number of Households by Type of Fuel Used for Lighting Purposes

Ward	Total Households	Households by fuel usually used for Lighting Purpose				Fuel type not stated
		Electricity	Kerosene	Bio-gas	Others	
Total	9551	9334	115	5	10	87
Percentage		**97.73**	**1.20**	**0.05**	**0.10**	**0.91**
1	441	436	4	0	1	0
2	358	355	2	0	0	1
3	476	455	19	0	1	1
4	339	335	1	0	0	3
5	345	333	2	0	0	10
6	288	286	0	0	2	0
7	509	506	3	0	0	0
8	431	416	11	0	3	1
9	278	278	0	0	0	0
10	380	369	4	1	2	4
11	407	391	1	0	0	15
12	388	375	8	1	0	4
13	620	601	17	0	0	2
14	434	433	1	0	0	0
15	1780	1745	12	1	0	22
16	1075	1056	13	0	1	5
17	1002	964	17	2	0	19

Very few households i.e. 10 use other various type of energy for the purpose of lighting in Madhyapur Thimi municipality.

Health and Sanitation

Although households of Madhyapur Thimi Municipality are getting drinking water from various sources, coverage of piped water (tap) is the highest. Out of total households, 55 percent get pipe water. After the tap, well, and tube well rank the second, and the third important sources respectively. Out of the total, about 24 and 16 percent households receive drinking water from well and tube well respectively in Madhyapur Thimi. Besides these sources, 3 percent households fetch water from the spring, and negligible proportion depends on other sources.

The proportions of households depending on piped water as the source of drinking water have little variation except in ward no. 15. Most of the households of all wards except in ward no. 15 are using piped water. However, about 53 and 30 percent households of ward no. 15 are depending on tube well and well for drinking water. The percentage of households using tube well for drinking water is ranging from 1 percent in ward no. 10 as the least proportion to 53 percent in ward no. 15 as the highest. Similarly, the percentage of households using well for drinking water is ranging from 3 percent in ward no. 1 as the least to 43 percent in ward no. 16 as the highest proportion. Beside these sources, about 17 percent households of ward no. 10 are depending on other sources.

Most of the households of Madhyapur Thimi Municipality have toilet facility. Among the total households of the municipality, about 48 percent have modern flush toilet and about 40 percent have ordinary toilet. However, about 11 percent households still use open toilet.

The proportion of household with different toilet facility is varying in different wards in Madhyapur Thimi Municipality. The proportion of households using modern toilet is ranging from 10 percent as the least in wards no. 2 to 99 percent as the highest in ward no. 14. The proportions of households using modern toilet are significantly higher in ward no. 4 and 14. Similarly, the proportion of households having ordinary toilet is ranging from 0 percent in ward no 14 to 75 percent in ward no. 16. Contrary to this the proportion of households having no toilet is ranging from 0 percent in ward no. 14 to 49 percent in ward no 3. Still, almost 5 percent of households of 5, 11, and 17 wards do not state their toilet facility there.

Solid Waste

The municipality has been found to generate 20 Metric Tonnes of solid waste and nearly 84 percent of this waste is from agricultural source and most of this is presently being disposed in open fields.

Baseline Data (2009)

2. Approach and Methodology

The approach and methodology used in the preparation of this baseline is according to the UNEP Guidelines prepared for the Characterization and Quantification of Waste Agricultural Biomass.

2.1 Approach

This baseline survey is undertaken by the questionnaires for household survey. The respondents would be using their general experiences and recall method to answer the questions. Hence, the enumerators were oriented accordingly as to how the conversation would be undertaken.

The study involved both primary and secondary data collection. As mentioned earlier, the majority of information relevant to this study was collected from the household survey questionnaire and interviews with local municipality officials, owners of the local pottery industries, rice mills, beaten rice (Chiura) mills, bakeries, community forestry users group and officials from the Office of Cottage and Small Industries at Bhaktapur.

2.2 Methodology

Development of Questionnaire and Checklist

SEED Nepal in consultation with biomass energy expert has prepared household questionnaires for this study. The study team worked with the questionnaires after discussion sessions with statistician and data analyzers. After making plans as to how to conduct field surveys, four numbers of enumerators were selected after interviewing them. Sampling of the households in the seventeen different wards of MTM was decided in consultation with the official of MTM. The enumerators were given orientation training on how to collect the data and engage in interview session by the study team.

Sample Selection

Agricultural Farms

The study area included 17 wards of Madhyapur Thimi Municipality. Since the project deals with Waste Agricultural Biomass, those households with their own agricultural or farmlands were selected. Out of 9,551 house hold in MTM, 4,600 households have their own agricultural lands. Out of the 4600 households, 300 sample households were selected randomly with representation from all 17 wards of MTM. The number of households selected from each ward is presented below:

Table 5: Selection of Samples in Wards

Ward No.	Total No. of Households	Agricultural HH	5%	Additional HH	Total HH
1	441	325	17	10	27
2	358	260	13	10	23
3	476	337	17	10	27
4	339	187	10	9	19
5	345	273	14	10	24
6	288	238	12	10	22
7	509	207	10	-	10
8	431	238	12	5	17
9	278	183	9	4	13
10	380	238	12	-	12
11	407	302	15	-	15
12	388	252	13	-	13
13	620	303	15	-	15
14	434	249	13	-	13
15	1,780	341	17	-	17
16	1,075	365	18	-	18
17	1,002	302	15	-	15
Total	**9,551**	**4,600**	**232**	**68**	**300**

Processing Facilities

Although as per the Office of the Cottage and Small Industries, there are 39 rice mills, 5 chiura (beaten rice) mills are registered only 12 rice mills and 4 chiura mills are found to be operational during the study period. Out of these two units each from the rice mills and chiura mills were taken as sampling units under processing facilities

Commercial Facilities

Vegetables grown in the project area is brought from the farm to a wholesale market at Nagdesh. The wholesale market operated only during very early hours in the morning and this caters to suppliers transporting vegetables to the market in Kathmandu. The project team has studied this market and also two vegetable retail markets at Kaushaltar and Gatthaghar.

Tools and Techniques used during Data Collection

The quantitative information on the waste biomass generated from the crops such as rice straw, wheat straw, corn stalk etc. and wastes from vegetables like cauliflower, cabbage, green vegetables, radish, carrot, Potato, beans etc were of utmost importance. The residents were generally requested to answer in local customary units which were then converted into standard units. For example, the local expression of rice straw quantity used to be in muttha. Usually, the respondents could interpret those quantities in standard units of say kg. Samples of such customary Muttha (Bunch) were weighed or roughly estimated by the interviewer wherever felt necessary.

Laboratory Analysis

Samples of Important WAB were collected and tested in an accredited laboratory for mainly moisture content and calorific value.

Data Entry and Analyses

The data collected from the field were checked and verified thoroughly by the expert especially statistician, prior to the computer entry. After completing all data information on SPSS 16, the statistical analyses were performed. The findings and result interpretation and presentation were done accordingly.

Workshop and feedback

A two-day workshop was conducted for the launching of the Project and training of the important stakeholders. Approach and Preliminary findings of the baseline study on Characterization and Quantification of WAB were also presented in the workshop. The feedback given by the stakeholders were used to further improve the baseline studies.

Limitations of the Study

The survey results in this report were basically derived from the analyses of information collected through household survey questionnaire from respondents of samples 300 household of the 17 wards, Vegetable market and Agro processing Industries of Madhyapur Thimi Municipality. The data and information obtained from the respondents were obviously based on recall of the respondents as there is no system of maintaining such data and information.

The boundary of the project area is limited to the seventeen wards of MTM and focused on major crops grown in the project area. Various Types of vegetables grown in the area have been grouped in order to simplify the survey.

Waste Agricultural Biomass Generation: Quantification and Characterization

3. Data Collection

The data collection has been done using the direct method at the point of generation using questionnaire. The waste generators were interviewed. There are three types of generators namely the Farmers, the processors and the commercial operators. Out of the 4,600 household with agricultural farm land, 300 household were surveyed as stated in Chapter 2. Similarly, out of 14 operational processing units only (12 rice mills and 4 beaten rice mills) 2 units each from rice mill and beaten rice mills were covered. On the side of the commercial facilities, all the three main markets have been studied. The following table presents on the studied samples:

Table 6: Sources of WAB sampled in MTM

Type of Sources		Number	Average Size	Remarks
Farm Land	1 – 16 Ana	91	11.8 Ana	
	17 – 64 Ana	169	41.4 Ana	
	Over 64 Ana	40	94.4 Ana	
	Total	300	39.5 Ana	
Processing Facility	Rice Mill	2	225 TPY paddy	
	Beaten Rice Mill	2	129 TPY paddy	
Commercial Facility	Gatthaghar Market	15	33 kg/day	Retail shops
	Kaushaltar Market	21	35 kg/day	Retail shops
	Nagdesh Whole Sale Market		Daily turnover of about 6000 kg	Caters to Market in Kathmandu

Note: 1 Ana = 342.25 sq. ft. = 31.8 sq. m.

3.1 Data Collected from Farm Land

Based on the responses of the surveyed households, the area of farm land and kitchen garden and the area of land on which rice, wheat, maize and vegetables are cultivated are presented below in a tabular form. Out of the 300 surveyed households, 77.4 % has their own land and 22.6 % is the rented farm land. Similarly 58.18 % of the kitchen garden is their own land and 41.9% of the land is rented kitchen garden.

Table 7: Land area of farm and kitchen garden

Farmland (Anna)			Kitchen garden (Anna)		
Own	Rented	Total	Own	Rented	Total
6541	1906	8447	1998	1436	3434

N.B: 1 Anna = 342.25 Sq. ft.

Table 8: Trend of Crops Production - Rice

	Cultivated land (Anna)			Yield (kg)			Straw(kg)
	2063/64	2064/65	2065/66	2063/64	2064/65	2065/66	2065
Rice	6299	6299	5837	136735	134642	110745	94880

The above table shows that in the fiscal year 2065/066, paddy is cultivated in 5,837 Annas of land and the production of Paddy is 110,745 kg (53.8%) and the production of rice straw is 94,889 kg (46.14%)

Table 9: Trend of Crops Production - Wheat

	Cultivated land (Anna)			Yield (kg)			Straw (kg)
	2063/64	2064/65	2065/66	2063/64	2064/65	2065/66	2065
Wheat	2734	2738	2442	20065	20570	13885	16290

The above table shows that in the year 2065/066, wheat is cultivated in 2442 Annas of land and the production of wheat is 13885 kg (46.01%) and the production of rice straw is 16290 kg (53.9 %)

Table 10: Trend of Crops Production - Maize

	Cultivated land (Anna)			Yield (kg)			Straw (kg)
	2063/64	2064/65	2065/66	2063/64	2064/65	2065/66	2065
Maize	117	117	117	551	595	365	482

Similarly, the above table shows that in the year 2065/066, maize is cultivated in 117 Annas of land and the production of maize is 365 kg (43.09%) and the production of maize stalk is 482 kg (56.9 %). The total production of crop residue in the year 2065/066 was **111,652 kg** (94880 for rice +16290 for wheat +482 for maize =111,652 kg).

Table 11: Trend of Vegetables production

Type of Vegetable	Cultivated land (Anna)			Yield (kg)			Type of waste	Waste (kg)
	2063/4	2064/5	2065/6	2063/4	2064/5	2065/66		2065
Cauliflower	364	368	306	12265	13490	9860	D (25)	1704
Cabbage	184	168	175	10870	13480	9070	C(13)	1710
Leafy Vegetables	4282	4266	4162	1398410	1433983	1435470	B(201)	194118
Beans	416	422	415	5500	5861	5905	C,D(18)	1399
Carrot Turnip	1845	1866	1811	171540	185205	170040	C(101)	17253
Potato	322	328	269	11054	12014	9180	C,D(26)	1841
Other (chilli)	507	508	496	60452	48872	38538	C,D(39)	4517

Note: Waste from Vegetables = **222,542 kg**; B: Root and Yellow leaf; C: leaves; D: Stalk

The above Table shows the trend of vegetable cultivation in the surveyed households. In the year 2065/066, Cauliflower is cultivated in 306 Annas of land and the production of Cauliflower is 9860 kg (85.26%) and the waste stalk is 1704 kg (14.73%). Cabbage is cultivated in 175 Anna of land in the year 2065/066 and the production of Cabbage is 9070 kg (84.13%) and the waste leaves are 1710 kg (15.86%). Similarly, the cultivation

of green leafy vegetables in the survey households in the year 2065/066 was in 4162 Annas of land and the production of vegetables was 1435470 kg (87.5%) and the generation of wastes as leaves was 19411kg (12.5%). In the year 2065/066, Beans like Bodi,

Bhatmas, Simi etc were cultivated in 415 Annas of land by the surveyed households and the production of beans was 5905 kg (80.8%) and the wastes leaves and stalk was 1399 kg (19.2%). In the same manner, vegetables like carrot, turnip and radish were cultivated in 1811 Annas of land by the surveyed households in the year 2065/066 and the production of radish, carrot were 170040 kg (90.8%) and the waste leaves were 17253 kg (9.2%). Potato was cultivated in 269 Annas of land in the year 2065/066 and the production of the tuber was 9180 kg (83.3%) and the waste leaves and stalk was 1841kg (16.7%). Finally, Chilli was cultivated in the 496 Annas of land by the surveyed households in the year 2065/066 and the production of Chilli was 38538kg (89.5%) and waste leaves and stalk was 4517 kg (10.5%).

Table 12: Total Waste from Farm land 300 households

Waste from Crops (a) kg	Waste from Vegetables (b) kg	Total Waste (A) = a+b kg
111,652	222,542	334,194

Above Table shows the total quantity of WAB generated by the surveyed household in the year 2065/066. Out of 334194 kg of WAB generated, 33.4% is from the crops and the remaining 66.6% WAB is generated from the Vegetable wastes.

Table 13: Surplus of WAB from farm land for 300 households

Waste Stream	Waste Generation (kg)	In-house consumption (kg)	Surplus/disposed (kg)
Rice Straw	94,880	38,663	56,217
Wheat Straw	16,290	6,639	9,651
Maize Stalk	482	196	286
Waste Veg	222,542	90,696	131,846
Total	334,194	136,194	198,000

3.2 Data Collection from Processing Industries:

One of the important sources where WAB is generated is the agricultural crops and other outputs processing industries. The agricultural crop after harvesting is taken to the industries for processing where the wastes are then produced. The information about the existing processing industries is collected from the Cottage Industry District Office in Bhaktapur. The number of processing industries available in MTM and registered in Bhaktapur District is given below.

Table 14: No of Industries registered

Type of Processing Facility	Registered industries in the years of range				Total
	2041-56	2056-60	2061-63	2062-66	
Rice mill	30	4	2	3	**39**
Beaten rice mill	4	1			**5**

Note: Only 12 units of small rice mills and 4 units of beaten rice mills are in operation

The data collected from the rice mills and the beaten rice mills are presented below:

Table 15: WAB from Processing Facilities

Source	Capacity Paddy used in Tons/year	Type of WAB	WAB Tons/Year			Method of Determination of WAB
			Generation	In house Consumption	Surplus	
Rice Mill 1	200	Rice Husk	53	3	50	Estimate from the Mill
Rice Mill 2	250	Rice Husk	66	3	63	
Beaten Rice Mill 1	105	Rice Husk	35.2	22	13.2	
Beaten Rice Mill 2	152	Rice Husk	52.8	33	19.8	
Total	**707**		**207**	**61**	**146**	

3.3 Data Collection from Vegetable Market:

Vegetable market is another important place where WAB is generated. Around 200 floriculture nurseries were registered in Floriculture Association of Nepal, an association under Federation of Nepalese Chambers of Commerce and Industry, within Kathmandu Valley. In MTM there are only 4 such nurseries operational. They are found to generate an average amount of waste around 60-70 kg/year. Since the waste generated is not so significant, these have not been included in the study. The data collected from the vegetable markets are presented below:

Table 16: WAB from Vegetable Markets

Source	Turnover Tons/year	Type of WAB	WAB Tons/Year			Method of Determination of WAB
			Generation	In house Use	Surplus	
Gatthaghar Market	210	Waste Vegetable	18	-	18	Estimate from the shop keepers
Kaushaltar Market	282	Waste Vegetable	27	-	27	
Nagdesh Wholesale Market	2,160	Waste Vegetable	108	-	108	
Total	**2,652**		**153**	**-**	**153**	

Combining all the wastes generated by the three sources, the WAB data from the survey is presented below:

Table 17: Overall WAB from all the Sources

Source	Type of WAB	WAB Tons/Year		
		Generation	In house Consumption	Surplus
Farm Land	Straw, Stalks, Waste Vegetable	334	136	198
Processing Facilities	Rice Husk	207	61	146
Vegetable Market	Waste Vegetable	153	-	153
Total for Samples		**694**	**197**	**497**

4. Calculation of Total WAB in the whole Project Area

Starting from the summed up data for 300 households as given in the section 3.1, the projected waste can be calculated for the entire municipality may be calculated as given below:

4.1 From Farm Land

The total WAB for 300 households from the farm land is 334,194 kg per annum. The WAB including their breakdown of the type for the whole project area from farm land is given in the table 18 and table19 below:

Table 18: Surplus of WAB from Farm Land for Project Area

Waste Stream	Waste Generation (Tons)	In-house consumption (Tons)	Surplus/ disposed (Tons)
Rice Straw	1,454.965	592.971	861.994
Wheat Straw	249.780	101.798	147.982
Maize Stalk	7.391	3.005	4.385
Waste Veg	3,412.311	1,390.672	2,021.639
Total	**5,124.446**	**2,088.446**	**3,036.000**

Table 19: Total WAB from farm land of whole MTM

WAB	Quantity	On the basis of households			On the basis of land area		
		Surveyed HH	Total agricultural households	Calculated quantity of WAB for MTM in Tons	Land area for sampled HH in ha.	Total agricultural land area in MTM in ha.	Calculated quantity of WAB for MTM in Tons
Generation	334.194	300	4,600	5,124	40.5	892	7,360.520
Own use	136.194			2,088			2,999.632
Surplus	198			3,036			4360.888

On the basis of the household, the calculated quantity is thus less than the total amount on the bases of the agricultural land area in the whole of the project area. Therefore, the quantity of WAB from the farm land on the basis of the household has been taken for our

study purpose and this is 5,124 Tons per year. Out of this quantity, after deduction of their in-house use the remaining quantity available is calculated to be 3,036 Tons per year. The breakdown of the available WAB in the project area after the deduction of internal use by type of WAB is given below:

Table 20: Surplus/disposed WAB from Agriculture Farm

S. No.	Type of WAB	Quantity in Tons
1	Rice Straw	861.994
2	Wheat straw	147.982
3	Maize stalks	4.385
4	Waste vegetables	2,021.639

4.2 From Processing Facilities

Total WAB from Processing Facility is given below:

Table 21: Total WAB from Processing Facilities

Source	Capacity Paddy used in Tons/year	Type of WAB	WAB Tons/Year			No of Sample	Total Number	WAB surplus in Tons/yr
			Generation	In house Consumption	Surplus			
Rice Mills	450	Rice Husk	119	6	113	2	12	678
Beaten Rice Mills	257	Rice Husk	88	55	33	2	4	66

4.3 From Commercial Facility

Total from Commercial facility is presented in the table below:

Table 22: Total WAB from Commercial Facilities

Source	Turnover Tons/year	Type of WAB	WAB Tons/Year		
			Generation	In house Consumption	Surplus
Total	**2,652**		**153**	**-**	**153**

Although there are small vegetable retailers scattered in the municipality, the generation of WAB from such retail shops has not been included in this study.

4.4 From All Facilities

Thus the cumulative total of all surplus WAB is presented in the table below:

Table 23: Total WAB in the MTM

S. No.	Type of WAB	Quantity in Tons
1	Rice Straw	861.994
2	Wheat straw	147.982
3	Maize stalks	4.385
4	Waste vegetables	2,021.639
5	Rice Husk from Processing units	744.000
6	Waste Vegetables from Commercial Facility	153.000
	Total	**3,932.965**

4.5 Time Series Data and Future Projections

It has been seen that the land area and the production for the cultivation of various crops has been decreasing as given below:

Table 24: Trend in Land Use and Production

Cultivation	Land area in Ana			Average Change %	Production in Kg			Average Change %
Rice	6,299	6,299	5,837	-3.7%	136,735	134,642	110,745	-9.6%
Wheat	2,734	2,738	2,442	-5.3%	20,065	20,570	13,885	-15.0%
Maize	117	117	117	0.0%	551	595	365	-15.3%
Veg	7,920	7,926	7,634	-1.8%	1,670,091	1,712,905	1,678,063	0.3%

Therefore, the projections of the WAB from farm land for 2 years are estimated as given in the following table:

Table 25: Present and Projection of WAB from Farm Land

S. No.	Type of WAB	Quantity for 2009 in Tons	% Change per year	Estimate for Year (Tons)	
				2010	2011
1	Rice Straw	861.994	-3.7%	830.100	799.386
2	Wheat straw	147.982	-5.3%	140.139	132.712
3	Maize stalks	4.385	0.0%	4.385	4.385
4	Waste vegetables	2,021.639	-4.1%	1,938.752	1,859.263
	Total	**3,036**		**2,913.376**	**2,795.746**

It is expected that the processing industries will remain the same in the project area. But the commercial market of the agricultural products is expending and it is estimated that the volume and the market size will increase by two times the existing volume and hence the WAB generation will also be triple of the current amount.

The present as well as the future projection of WAB from all the three sectors is presented below:

Table 26: Present and Projection of WAB from all Sectors

S. No.	Type of WAB	Quantity (2009) in Tons	% Change per year	Estimate for Year in Tons	
				2010	2011
From Farm Land					
1	Rice Straw	861.994	-3.7%	830.100	799.386
2	Wheat straw	147.982	-5.3%	140.139	132.712
3	Maize stalks	4.385	0.0%	4.385	4.385
4	Waste vegetables	2,021.639	-4.1%	1,938.752	1859.263
From Processing Facility					
5	Rice Husk from Processing Units	744.000	-	744	744.000
From Commercial Facility					
6	Waste Vegetables from Commercial Facility	153.000	2 times per year	306	459.000
	Total	**4,033.999**		3,963,376	3,998.746

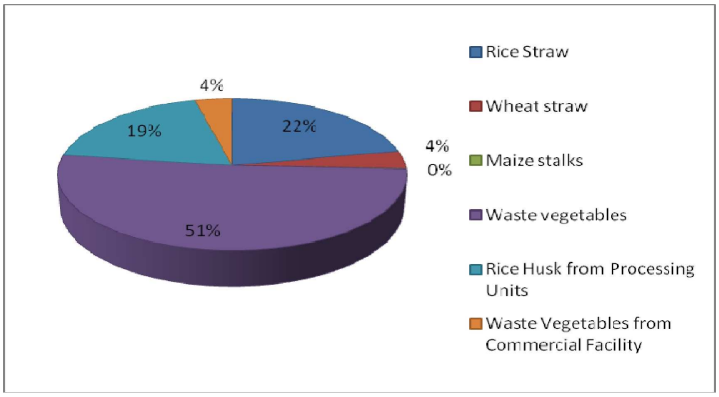

Figure 2: Surplus WAB in MTM for 2009

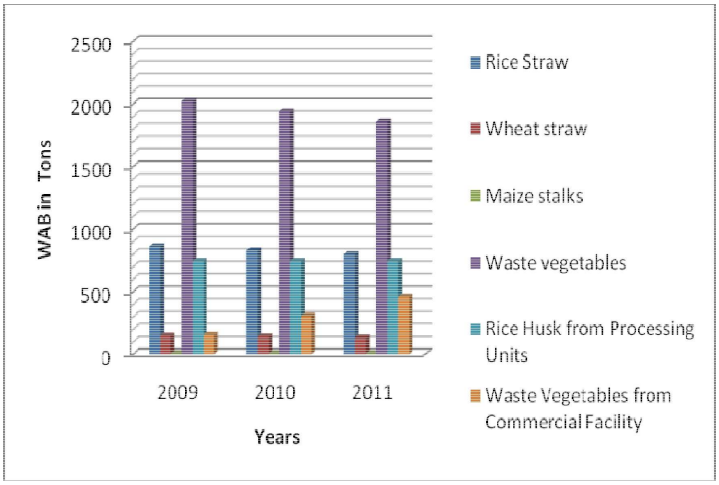

Figure 3: Time Series Data for WAB 2009 - 2011

5. Characterization of the Waste Agricultural Biomass

Visual characteristics, moisture content, composition and calorific values were studied under characterization of the WAB in the Project area.

5.1 Visual Characteristics

The visual inspections were carried out in the fields or farms, processing facilities and commercial market facilities to find out the visual characteristics. Due to the seasonal nature only some observations were possible. But the survey team also discussed with the farmers on the type of WAB being generated.

From Farm

With regards to the paddy or wheat cultivation, the WAB generated is rice or wheat straw. Actually 3 to 4 inches of straw is left in the field while harvesting. As the harvesting is manual, comparatively the straw is clean. It is left for drying in the field itself. In this period it can get contaminated with mud and other foreign materials.

The straw and root left in the field is currently not used and before plantation of next crop the land is tilled so that the straw is covered by mud to leave it for decaying or in some cases it is openly burnt.

Residues from the vegetables are widely different and they include the leaves, the stalks, climbers and the roots which are not useful for selling in the market. Some portion of the waste is also seen as eaten by some insects or in process of decay due to some plant disease.

From Processing Facility

The main WAB from the processing facilities is the rice hull or husk. Generally these are not contaminated with any foreign materials.

From Commercial Market

The wastes from the commercial facility consist of old unsold vegetables, non-edible part of the vegetables and some infected / rotten portion of the vegetables.

5.2 Moisture Content

As the moisture content is necessary for further use of the WAB, samples of WAB generated were taken and sent for analysis at an accredited laboratory. According to the analysis, the average moisture contents in the samples were as follows:

Table 27: Moisture Content of WAB

S. No.	Sample	Average Moisture (%)
1	Rice straw	9.8
2	Wheat straw	12.4
3	Maize	54
4	Rice husk	11.2
5	Waste Vegetables	74.4

As the moisture content can vary due to weather conditions and as it was still raining in the Valley and the project area, the moisture content results show that the moisture content is actually higher than their usual average value.

5.3 Calorific value[1]

To calculate the energy value of WAB, the calorific value of the generated WB is needed. The samples collected were given to laboratory for also determining the calorific value. However, due to long leave of the personnel on the longest festival of Dashahara in the country, the calorific value determination could not be completed in time. For the present study, however, secondary data and values have been used as given below:

Table 28: Gross Calorific Value of WAB

S. No.	Sample	Calorific Value Kcals/kg
1	Rice straw/ Paddy straw	3,000
2	Wheat straw	3,800
3	Maize	3,500
4	Rice husk	3,040
5	Waste Vegetables	3,590

Calculation of Net Calorific Value

The calculated values of net calorific values are presented in the table below:

Table 29: Net Calorific Values of WAB

Waste Stream	Gross Calorific Value (CV)	Hydrogen (H)	Moisture Content (MC) %	Net calorific Value
Rice Straw	3,000	5.28	9.8	2,704
Wheat Straw	3,800	5.3	12.4	3,328
Maize Stalk	3,500	5.17	54	1,608
Rice Husk	3,040	4.91	11.2	2,699
Waste Veg	3,590	5	74.4	917

Table 30: Overall Status of Quantification and Characterization of WAB

Waste Stream	Gross generation	Already consumed	Surplus/ disposed	Moisture Content(%)	Dry Quantity	GCV kcal/kg	Net CV kcal/kg
From Agricultural Land							
Rice Straw	1,454.965	592.971	861.994	9.8	777.5186	3,000	2,704
Wheat straw	249.780	101.798	147.982	12.4	129.6322	3,800	3,328
Maize stalks	7.391	3.005	4.385	54	2.0171	3,500	1,608
Waste vegetables	3,412.311	1,390.672	2,021.639	74.4	517.5396	3,590	917
From Processing Units							
Rice Husk	890	146	744	11.2	660.672	3,040	2,699
From Commercial Facilities							
Waste Vegetables	153.000	-	153	74.4	39.168	3,590	917

[1] http://wgbis.ces.iisc.ernet.in/energy/paper/alternative/calorific.html **date: 29 September 2009**

5.4 Cost Data

Paddy straw, wheat straw and rice husk are only sold. Other WAB materials are not sold or they do not have any value in the market. The prices of the sold materials are also not fixed at all. They vary a lot depending on the season, availability and place, where it is being sold. The following table gives the average value of the price during the study period.

Table 31: Cost Data for WAB

S. No.	Type of WAB	Price in Rs./kg
1	Paddy Straw	1.80 to 2
2	Wheat Straw	1.80 to 2
3	Rice Husk	2 to 3

The transportation charge also varies depending on the mode and quantity to be transported.

6. Conclusion

The baseline study on the characterization and quantification of Waste Agricultural Biomass for the Madhyapur Thimi Municipality (project area) has been completed according to the UNEP guidelines. The quantity of WAB from all the important three sectors namely the farm land, processing units and commercial facilities (vegetable markets) have been obtained through the sample survey. The quantity of WAB generated, used by themselves and surplus or disposed has been estimated for the whole municipality using the survey data. These quantities have also been projected for the years 2010 and 2011.

The visual characteristics have been presented and moisture contents of WAB have been determined in the laboratory. The calorific values have been calculated so that the heat values will be available easily. The related cost data are also collected and presented in the report.

Therefore, the data and information in the report will be useful for the analysis and choice of the Environmentally Sound Technology for converting WAB into resource.

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