EVALUATION OF SOLID WASTES OF KALIMATI FRUITS AND VEGETABLE WHOLESALE MARKET[3]

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ABSTRACT

This study focuses mainly on providing a firm base of information required for proper management of solid wastes generated in Kalimati Fruits and Vegetable Wholesale Market (KFVWM). The study was conducted from December 2002 to February 2003. The major objective of this study was to segregate and analyse the individual components of the waste generated inside KFVWM. Based on the quantity of market arrivals, major determinants of solid waste generation were evaluated.

Waste samples were taken from the waste heap for the segregation of the different components of solid wastes. A simple regression model was estimated to evaluate the major determinants of solid waste. Further, waste and volume characteristics of solid waste were examined by employing simple weight and volume ratios. Solid waste was categorized broadly according to nature – biodegradable and non-biodegradable and according to the origin – agricultural origin and non-agricultural origin. It was found that 84 percent by volume and 93 percent by weight of solid wastes are biodegradable in nature and can be taken for composting. The rest comprised of non-biodegradable ones which could be separated before further treatment. Likewise, agricultural origin waste made of 69 percent by volume and 87 percent by weight of the total waste. The biodegradable and agricultural origin waste carried a higher density than the non-biodegradable and non-agricultural origin waste suggesting that they are a good input for a composting plant. It was also found that market arrival was the significant determinant of solid waste generation.

Through the findings of the study, it is recommended that the biodegradable component of solid wastes of KFVWM should be utilised in making compost in order to reduce the environmental and social impacts of solid wastes. For this purpose, biodegradable and non-biodegradable wastes have to be segregated. Also, enough consideration has to be given to the weight and volume of the different components of waste so that it will ensure a sustained operation of the compost plant.

INTRODUCTION

Statement of the Problem

KFVWM is one of the largest generators of solid wastes inside Kathmandu Valley. Being a fruit and vegetable market, it is a huge source of organic wastes and the potential for recycling these wastes into composts and similar useful commodities is immense. At present, these wastes are far from being properly utilized. Despite its potential, it is still unanswered as why are not these organic wastes being recycled? Even if they are recycled, why are they not being recycled to the full extent? The answer is simple. Besides the existing potential, opportunities and challenges for management of these wastes do exist and they need to be assessed properly first hand. Lack of data and reliable information is the major cause of the mismanagement of these resources. It is necessary to obtain reliable information before planning for the proper

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3. This paper is based on principal author's MS Thesis submitted to Pokhara University in May 2003.

management of these wastes. If there is willingness to properly utilize these wastes, a firm base of information is needed to be able to do it effectively and efficiently.

Kathmandu Municipality has been encouraging people to compost their household waste. But, so far, this effort has been implemented in only limited places of Kathmandu Municipality. Nevertheless, it is a promising effort, which may solve the solid waste related problems in the years to come. However, wastes generated from institutional levels like KFVWM are huge in volume and it aggravates the solid waste problems. Regarding this, enough attention of the concerned authorities is lacking and the policy and information needed regarding this institutional waste is virtually absent.

Objectives

The specific objectives are to quantify the amount of daily market arrivals of agricultural products, and segregate and analyse the different components of waste generated inside KFVWM.

METHODOLOGY

Conceptual Framework

Generally, municipal solid waste management (SWM) process consists of five different activities to be carried out at different stages and places (Parajuli, 1996). These are source separation (on-plot management), collection and transportation, unloading and treatment, secondary transportation, and final disposal. Source separation or on-plot management is an important activity, which is carried out at household level. Various types of wastes are separated into compostable waste, combustible waste, recyclable waste and landfill waste.

The major market functions that produce solid wastes are the process of grading, handling (packaging, cleaning, etc.) and distribution, which take place in the market. The farmers and the intermediaries who deliver their products into the market do not practice the process of grading, cleaning and packaging at the point of production and shipping. Major portion of solid wastes in the market are the rotten and unwanted products. It is suggested that about 10 to 12 percent out of 300 to 400 mt per day market arrivals are wasted as rotten and unwanted. An average of about two trips (about 10 mt) of solid wastes are generated daily.

Analytical Framework

Market arrivals: Market arrivals are the various agricultural products (fruits, vegetables, spices, etc.) produced by the farmers from different parts of the country. The daily arrival quantity for 45 consecutive days was determined from the data supplied by KFVWM Development Board.

Measure of solid wastes: The wastes are lifted and transported in garbage trucks. Hence, the general information available was the volume of the waste only. In order to derive its weight, the sample volume of waste was weighed. By using unitary method, the weight of the generated wastes was then computed.

Determinants of waste generation: Total quantity of wastes generated in the market is a function of market arrival.

$$W = f(M) \quad \text{............} \quad (1)$$

Hence, a simple linear regression model of the following type was used in this study.

$$W = a + bM + e \quad \text{............} \quad (2)$$

Where, W = daily waste generation,

M = market arrival,

a and b = coefficients to be estimated, and

e = random disturbance term assumed to be independently and identically distributed as $N(0,\sigma^2)$.

This model was also used for total wastes and total arrival of vegetables as well to see the significance of vegetables in waste generation in the market.

The Data

Waste sample were taken daily for 15 consecutive days. The waste samples were segregated component-wise. Each component of the waste was measured in terms of volume and was weighed as well. Approximate daily waste generation was calculated using the sample data for 15 consecutive days. Following Dhungana (2002:30-31), Thapa (1998:71-72), Upton (1973:215-217) and Yang (1965:5-11), there were 30 samples taken to segregate the components of waste. There was a total of 30 litres sample (morning 15 litres + afternoon 15 litres) taken daily for 15 days. These samples were weighed and an average for 15 days (thirty litres/day) was computed. This average weight was used to get the waste estimate for the first 15 days and the third 15 days of the 45 sample days. Nevertheless, for the second 15 days, the real data obtained was used to derive total waste generated. For determining the daily waste generation, percent filled of truck's tipper was noted for 45 consecutive days (coincided with the days for which market arrival data were taken). This survey was conducted from December 2002 to January 2003.

EVALUATION OF WASTE SAMPLES AND DISCUSSION

Sample Weight

Samples were taken in 15-litre bucket. While the volume of the sample was taken constant at 15 litres, the weight of each sample was weighed and it was found out that the average weight of the15 litre samples was 5.575 kg. Segregation of the waste samples into waste components revealed that there were a total of 33 different types of materials present in the samples.

Component-wise Market Arrivals and Waste Generation

Market arrivals are the primary determinants of waste generated from KFVWM. Figures 1 and 2 show the percentage of major components and the corresponding waste generated.

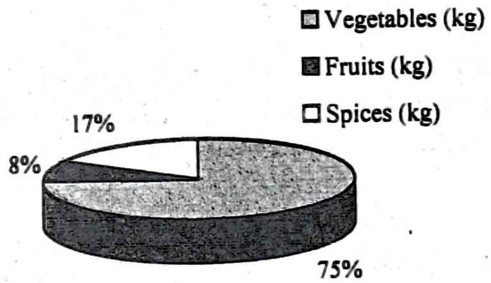


Figure 1: Percentage of market arrivals of major categories

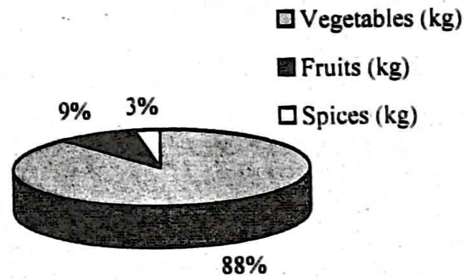


Figure 2: Percentage waste of respective market arrivals

It was found that vegetables are the dominant market arrivals followed by fruits and spices. Due to greater arrival, a large amount gets discarded at a faster rate than other group of commodities. Spices are dry and wastage is low. Similarly, fruits (like oranges, apples, etc.) are less perishable compared to green vegetables, which makes it possible to retain them for a longer period.

Bio-degradable Wastes

Among the components segregated, it was found that 22 components (Annex 5) were of biodegradable nature. The average volume and weight was calculated as 13.7 litres and 4.9 kg., respectively. It was 84 percent of the total waste by volume and 93 percent by weight (Figures 3 and 4).

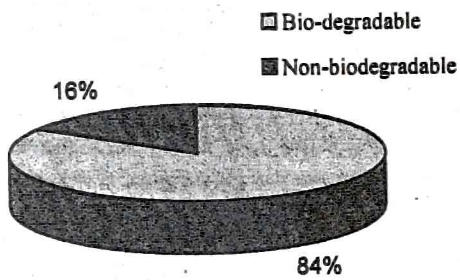
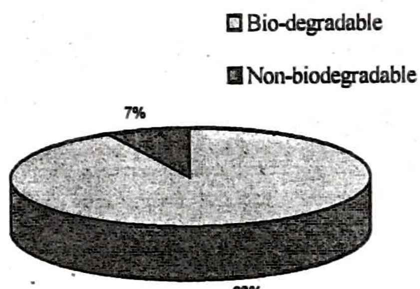


Figure 3: Percentage of Biodegradable and Non -biodegradable waste by volume



Figuer 4: Percentage of Biodegradable and Non-biodegradable waste by weight

The percentage of weight of biodegradable waste is greater than percentage of its volume as compared with non-biodegradable waste. It reflects that this type of waste possesses a greater weight per unit volume and its contribution to the total waste generated is greater in terms of its weight. It should not be misunderstood that a larger volume of biodegradable waste will make a good raw material for composting plants because the presence of high volume less weight components like paper, jute and straw will cause a significant difference in the total weight of the compostable materials. Individual means of the 22 components were calculated and their significance was tested at different levels of significance (Table 1).

Non-biodegradable Wastes

Among the samples segregated, it was found that 13 components were of non-biodegradable in nature. The average volume and weight of this category was found to be 2.6 litres and 0.39 kg, respectively. It comprised of 16 percent of the total volume of waste, and seven percent of the total weight of the waste (Figures 3 and 4).

The percentage of volume of non-biodegradable waste is greater than percentage of its weight. It implies that this type of waste possesses a greater volume and its weight per unit volume is much lesser. Thus, contribution to the total waste generated is greater in terms of its volume. While considering the large bulk volume of the wastes for composting, it will be necessary to sort out these non-biodegradable wastes. For that purpose, it will be important to determine the component and quantity of non-biodegradable waste.

Table 1: Mean values of biodegradable wastes

Variables	Mean volume (litres)	Mean weight (Kg.)
Vegetables	2.468*** (0.163)	1.686*** (0.119)
Vegetable Leaves	4.397*** (0.156)	1.784*** (0.105)
Spices	0.350*** (0.042)	0.103*** (0.022)
Fruits	0.350*** (0.076)	0.339*** (0.049)
Fruit Leaves	0.060* (0.034)	1.686^{ns} (0.018)
Paper/paper cartons	2.113*** (0.228)	1.784*** (0.025)
Straws	1.090*** (0.144)	0.103*** (0.023)
Plant Leaves	0.893*** (0.185)	0.339*** (0.027)
Fruits and Vegetable peels/skins	1.070*** (0.095)	0.247*** (0.030)
Wood/wood cartons	0.238*** (0.040)	0.061*** (0.013)
Jute net/rope/threads	0.251*** (0.057)	0.062*** (0.018)
Grinded matter (50%)	0.143*** (0.037)	0.005*** (0.027)
Miscellaneous	0.129*** (0.035)	0.02*** (0.01)

Note: *** and * refer to significance at 0.01 and 0.1 levels respectively
ns: refers to not significant
figures in parenthesis indicate standard error

Individual means of the separate components were calculated and were tested at different levels of significance (Table 2).

Agricultural Origin Waste

Among the 33 components separated, 18 of them were found to be of agricultural origin. The average volume and weight of this category was found to be 11.3 litres and 4.6 kg, respectively. It comprised 69 percent of the total volume and 87 percent of the total weight of waste (Figures 5 and 6).

The percentage of weight of agricultural origin waste is greater than percentage of its volume. It means that this type of waste possesses a greater weight per unit volume and its contribution to the total waste generated is greater in terms of its weight. This is particularly true for agricultural product wastes viz. vegetables, fruits and spices because they have a greater mass content per volume. However, agricultural origin waste such as straws and jute carry a lesser weight per volume. Their contribution to the total waste generated is more important in terms of their volume (refer Table 3 for comparison of their mean volume and weight).

Table 2: Mean values of non-biodegradable wastes

Variables	Mean volume (litre)	Mean weight (Kg.)
Plastic/Plastic sacs	1.937*** (0.183)	0.126*** (0.020)
Plastic/nylon ropes/threads	0.156*** (0.028)	0.018*** (0.003)
Stones/bricks	0.037** (0.017)	0.045** (0.020)
Glass wares	0.027^ns (0.018)	0.010** (0.004)
Apple covering (Styrofoam)	0.178** (0.073)	0.011*** (0.003)
Grinded matter (50%)	0.143*** (0.037)	0.005*** (0.027)
Miscellaneous	0.05*** (0.02)	0.03** (0.01)

Note: ***, and ** refer to significance at 0.01, 0.05 levels respectively.
ns refers to not significant
figures in parenthesis indicate standard error

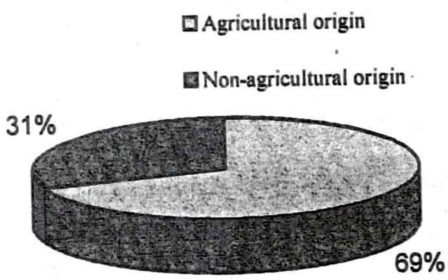


Figure 5: Percentage of Agricultural and Non-agricultural origin waste by volume

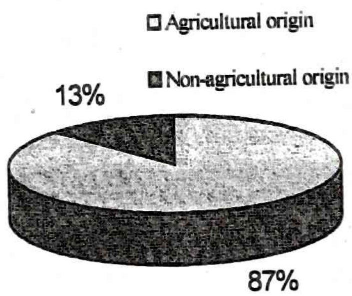


Figure 6: Percentage of Agricultural and Non-agricultural waste by weight

Nevertheless, as a whole, agricultural origin waste are the major waste generated in KVFWM but while considering these waste for a composting of similar project, it will be necessary to determine the component and quantity of these waste. It is not always

Nevertheless, as a whole, agricultural origin waste are the major waste generated in KVFWM but while considering these waste for a composting of similar project, it will be necessary to determine the component and quantity of these waste. It is not always true that a larger volume of agricultural origin waste will make a good raw material for composting plants because the presence of high volume less weight components like jute and straw will cause a significant difference in the total weight of the compostable materials. Individual means of the components were calculated and their significance was tested at different levels (Table 3).

Table 3: Mean values of agricultural origin wastes

Variables	Mean volume (litre)	Mean weight (Kg.)
Vegetables	2.468***	1.686***
	(0.163)	(0.119)
Vegetable Leaves	4.397***	1.784***
	(0.156)	(0.105)
Spices	0.350***	0.103***
	(0.042)	(0.022)
Fruits	0.350***	0.339***
	(0.076)	(0.049)
Fruit Leaves	0.060*	1.686*
	(0.034)	(0.018)
Straws	1.090***	0.103***
	(0.144)	(0.023)
Plant Leaves	0.893***	0.339***
	(0.185)	(0.027)
Fruits & Veg. peels/skins	1.070***	0.247***
	(0.095)	(0.030)
Jute net/rope/thread	0.251***	0.062***
	(0.057)	(0.018)
Grinded matter (50%)	0.143***	0.005***
	(0.037)	(0.027)
Miscellaneous	0.069**	0.012**
	(0.027)	(0.004)

Note: ***, ** and * refer to significance at 0.01, 0.05 and 0.1 Levels respectively.
figures in parentheses indicate standard error

Non-agricultural Origin Waste

Among the 33 variables separated, 16 of them were found to be of non-agricultural origin. The average volume and weight of this category was calculated to be 5 litres and 0.66 kg, respectively. It comprised 31 percent of the total volume and 13 percent of the total weight of waste (Figures 5 and 6).

The percentage of volume of non-agricultural origin waste is greater than percentage of its weight. It implies that this type of waste possesses a greater volume and its weight per unit volume is much lesser. This is true for plastics, styrofoam, and nylons because they carry much lesser weight compared to its volume. However, non-agricultural wastes such as glass and stones carry a greater weight per volume. Their contribution to the total waste generated is more important in terms of their weight than volume. Further, this category of waste comprise of not only non-biodegradable wastes but also biodegradable waste such as wood. Nevertheless, as a whole, non-agricultural origin wastes, even though in lesser quantity than agricultural origin waste are present in the waste generated in KVFWM. While considering the large bulk volume of the wastes for composting, it will be necessary to sort out biodegradable and non-biodegradable components of non-agricultural wastes. Individual means of the components were calculated and their significance was tested at different levels (Table 4).

Table 4: Mean Values of non-agricultural origin waste

Variables	Mean volume (Litre)	Mean weight (Kg.)
Paper/paper cartons	2.113*** (0.228)	1.784*** (0.025)
Plastic/Plastic sacs	1.937*** (0.183)	0.126*** (0.020)
Wood/wood cartons	0.238*** (0.040)	0.061*** (0.013)
Plastic/nylon ropes/threads	0.156*** (0.028)	0.018*** (0.003)
Stones/bricks	0.037** (0.017)	0.045** (0.020)
Glass wares	0.027[ns] (0.018)	0.010** (0.004)
Apple covering	0.178** (0.073)	0.011*** (0.003)
Grinded matter (50%)	0.143*** (0.037)	0.005*** (0.027)
Miscellaneous	0.113*** (0.037)	0.042*** (0.013)

Note: *** and ** refer to significance at 0.01 and 0.05 levels respectively.
ns refers to not significant
figures in parenthesis indicate standard error

Market Arrival as a Function of Solid Waste Generation

In order to evaluate the market arrival as a function of solid waste generation, the stochastic model as given in Equation (2) was estimated by using Ordinary Least Square (OLS) technique. The estimated results are presented in Table 5. The estimated F-value was significant. The value of R^2 was 0.5312. This model is good enough to explain 53.12 percent variation in solid waste generation. The estimated coefficients for market arrival were also positively significant in determining the tonnage of solid waste generation. The elasticity of waste generation was 76 percent, which shows that for every 1 percent increase in the market arrival, there is an increase in solid waste generation by 0.76 percent.

Table 5: Stochastic waste generation function estimates

Variable	OLS estimates
Constant	0.4976* (0.2462)
Market arrival	0.0036** (0.0005)
F-value	48.7259**
R-squared	0.5312
Number of observation	45

Note: * and ** refers to significance level at 0.1 and 0.01 levels respectively
figures in parenthesis indicate standard errors

CONCLUSIONS AND RECOMMENDATIONS

It was found that 84 percent by volume and 93 percent by weight of solid wastes are biodegradable in nature and can be taken for composting. The rest comprised of non-biodegradable ones which could be separated before further treatment. Likewise, agricultural origin waste made of 69 percent by volume and 87 percent by weight of the total waste. The biodegradable and agricultural origin waste carried a higher density than the non-biodegradable and non-agricultural origin waste suggesting that they are a good input for a composting plant. It was also found that market arrival was the significant determinant of solid waste generation.

Through the findings of the study, it is recommended that the biodegradable component of solid wastes of KFVWM should be utilised in making compost in order to reduce the environmental and social impacts of solid wastes. For this purpose, biodegradable and non-biodegradable wastes have to be segregated. Also, enough consideration has to be given to the weight and volume of the different components of waste such that it will ensure a sustained operation of the compost plant.

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