**Feasibility of Recycling of Municipal Solid Waste in Selected Municipal Corporations of Karnataka: An Economic Analysis**

**Abstract**

Solid waste is the most visible form of environmental problem in many urban regions in recent years. The increased generation of solid waste and diversification in solid waste generation is attributed to many factors such as rising population, changing income, consumption pattern, economic development, urbanization and industrialization. The research was conducted to know the extent of recycling of solid waste and its feasibility. The secondary data on various aspects of solid waste was collected from selected Municipal Corporations (BBMP and HDMC). The primary data was obtained from farmers using recycled solid waste from 30 sample farmers under each municipal corporation. Out of 30 farmers, 15 farmers who were using vermicompost prepared out of solid waste were selected and the remaining 15 were non-users of vermicompost. The results indicated that, nearly 62.00 to 65.00 per cent of solid waste generated was biodegradable which can be easily converted in to vermicompost. Out of the total solid waste generated in Hubballi-Dharwad (400t/day), about 390 t of waste was dumped in two open dumping yards while, only 10 t (2.5 %) was processed through vermicomposting whereas in Bengaluru, about 3,200 t of solid waste per day was landfilled in three sites and only 1,000 t (22.22 %) and 300 t (6.67 %) were processed into vermicompost and bio methanation process, respectively. The recycling of bio-degradable solid waste into vermicompost has high scope and was found to be financially feasible as implied by high IRR (26.12 % in Hubballi-Dharwad to 32.34 % in Bengaluru) and B:C ratio (1.50 and 2.04, respectively) with an investment recovery period of just two years. Therefore, the efforts should be made to convert biodegradable waste in to vermicompost in a larger scale in order to reduce the burden on the landfills and also the use of chemical fertilizers. Further, the segregation of solid waste at source level will make it easy.

**Key words: Solid waste, Recyclable, Urbanization, Pollution,**

**Introduction**

Environmental pollution includes air pollution, water pollution and land pollution. According to (Schoot *et al*., 2011), solid waste is undesirable material disposed of by man, which can neither and causes air, water, and soil pollution or any material that we discard, that is not liquid or gas, and is solid waste. Solid waste is not just deleterious to a single part of environment but to the whole environment. Solid waste problem surpasses traditional environmental boundaries and augment air, water as well as land pollution. It is the most visible form of environmental problem in many urban regions. The increased generation in solid waste and diversification in solid waste generation is attributed to many factors such as rising population, changing income, consumption pattern, economic development, urbanization and industrialization. It creates environmental hazards in terms of health risks from flies and rats, pollution of water bodies through runoff and rainfall, pollution of groundwater from leachate, air pollution from burning of wastes, and aesthetics aspects as well (Mazhar *et al.,* 2021).

In India, the development process caused by the galloping urbanization and industrialization requires a greater impetus towards building required infrastructure to meet the civic needs of increasing population. However, the equivalent and much needed expansion in infrastructure and services in urban centers are not happening. The unbalanced process of urbanization and modernization leading to increased pressure on natural resources and there by inefficient utilization of resources and also resulted in to depletion and degradation of natural resources. One of the important features of urbanization in India is the tendency towards concentration of population in larger urban centers. It leaves several issues unmanaged mainly with water supply, solid waste disposal and environmental decay and later get manifest in complex web of social and health problems. In addition, poor collection and inadequate transport contribute to the accumulation of solid waste in every corner of Indian cities (Alam *et al.,* 2021)

**Composition of solid waste**

Composition of Municipal Solid Waste is influenced by a variety of aspects including as food habits, cultural customs, climatic factors, and revenue, among others (Agamuthu *et al.,* 2007). MSW in India primarily consists of degradable waste (paper, textiles, food waste, straw, and yard trash), partially degradable waste wood (disposable napkins and sludge, sanitary residues), and nondegradable products such as leather, plastics, rubbers, metals, glass, ash from fuel burning (coal, briquettes, or woods), dust, and electronic waste (Gupta *et al*., 1998., Ahluwalia and Patel, 2018., MNRE, 2018). The MSW C/N ratio is anticipated to range between 800 and 1000 kcal/kg. Food waste contains a lot of moisture, which contributes a lot to MSW (Thitame, 2010). Paper, glass, metals, plastics, and textiles are used more by high-income groups than by low-income groups, resulting in bigger volumes of paper, glass, metals, plastics, and textiles (Sridevi *et al*., 2012).

**Methodology**

The study was taken up in Karnataka state. In order to analyze the Research objective, two municipal corporations having highest volume of solid waste generation were selected. The secondary data on solid waste generation, collection, storage and disposal was collected from each of the selected Municipal Corporation (Hubballi-Dharwad Municipal corporation, HDMC and Bruhat Bengaluru Mahanagara Palike, BBMP). Further, the data on extent of recycling of solid waste, cost and benefit from recycling of waste and method followed in dumping of solid waste was collected from both the municipal corporations.

**Analytical tools and techniques**

1. **Tabular presentation technique**

The secondary data collected from the BBMP and HDMC office was tabulated and the descriptive statistics like averages, percentages, *etc* were used to compile the data on nature and composition of solid waste, source wise generation, classification of solid waste and extent of recycling of solid waste in the selected municipal corporation.

1. **Financial feasibility analysis**

The techniques used for the financial analysis were:

1. Pay Back Period (PBP)
2. Net Present Value / worth (NPV)
3. Benefit-Cost Ratio (B: C Ratio)
4. Internal Rate of Return (IRR)

The discount rate for financial analysis was assumed to be 12 per cent because it was long term lending rate of interest.

**1. Pay Back Period (PBP)**

Payback period represents the length of time required for the stream of cash proceeds produced by the investment to be equal to the original cash outlay i.e. the time required for the project to pay for itself. In the present study, payback period was calculated by following formula.

Initial investment

PBP = ————————————

Net returns (average)

##### **2. Net Present Value / worth (NPV)**

The present value represents the discounted value of the net cash inflows to the project. In the present study, a discount factor of 12 per cent was used to discount the net cash inflows representing the opportunity cost of capital. It can be represented by



Where,

Yi = the net cash inflows in the year i r = the rate of discount

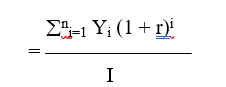
i = Year of life period (1,2,3,.. n) I = Initial investment

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##### **3. Benefit: Cost ratio**

The benefit cost ratio (BCR) was worked out by using following formula.

B:C ratio =



##### **4. Internal rate of return**

The rate at which the net present value of project is equal to zero is internal rate of return (IRR) to the project. The net cash inflows were discounted to determine the present worth by the following interpolation technique.

Lower discount rate

Present worth of cash flow at lower discount rate

Absolute difference between the present worth of cash flows at the two discount rates

Difference between two discount rates

IRR =

+ X

X

x x

##### **5. Budgeting technique**

Budgeting technique was used to estimate the cost and returns in production and sale of vermicompost in the selected municipal corporations.

**Results and discussion**

1. **Source wise generation of solid waste in study area**

There were many sources of generation of municipal solid waste such as food waste generated by households and from hotels, commercial areas, institutional areas, industrial waste, construction and demolition waste, and sanitation waste. The source wise generation of solid waste indicated that households and hotels were the major contributors of solid waste (Table 1). The waste from these households, hotels and markets together contributed 80 per cent and 77 per cent of the total waste generated, respectively in Hubballi-Dharwad and Bengaluru cities. This is in conformity with the results of Babu (2000) who reported that highest contribution of households was 181 t followed by markets (40 t) and restaurants (30 t).

The major portion of solid waste generated was degradable comprised of kitchen waste (fruit and vegetable peels, food waste). The other sources of solid waste generation were commercial area, institutional area and industries. Solid waste generated by institutional areas was paper, card boards and small portion of plastics which was recyclable while solid waste generated by commercial areas comprised more of plastics which is neither be degraded nor be recycled. The solid waste generated by industries was mainly comprised of toxic substances like heavy metals, paints, pesticides, used batteries, medicines. The understanding of sources of solid waste generation will help in formulation of strategies and approaches for better solid waste management practices. Both the municipal corporations have made it compulsory for households to segregate the waste before handing over to the sanitary workers nevertheless it was not effectively implemented. In Bengaluru, to encourage segregation of solid waste at source BBMP has established 189 dry waste collection centers. To have system for bulk generators like hotels, restaurants, marriage halls, apartments etc, BBMP has issued public notification to have their own insitu facilities to process their waste or to make use of services of BBMP service providers. To dispose construction and demolition waste, the BBMP has identified 8 locations.

1. **Classification of municipal and household solid waste**

The information of nature and composition of solid waste generated in an area is necessary in order to monitor and review waste management system. The nature and composition of waste generated is influenced by geographical locations, households socio-economic conditions, functional activities and government policies. With the rising urbanisation, per capita income and change in the life styles and food habits, the amount of municipal solid waste generation has been increasing rapidly and its composition is also changing across cities. It is observed in table that (Table 2), of the total waste generated (400 t/day) in HDMC area about 260 t/day (65.00 %) was degradable, 80 t/day (20.00 %) was non-degradable and 60 t/day (15.00 %) was inerts. Based on recyclability of solid waste, the percentage of recyclable and non-recyclable solid waste was 284 t/day (71.00 %) and 116 t/day (29.00 %), respectively. In Bengaluru, the proportion of degradable waste was 60.00 per cent (2700 t/day) and non-degradable was 25.00 per cent (1125 t/day). Belel and Mahmoud (2013) in their study also reported that about 67.60 per cent were biodegradable materials and 32.40 per cent were recyclable materials.

The municipal solid waste generated in both the cities was largely of biodegradable (61 to 65 %) in nature with higher proportion of organic content and useful raw material in abundance for vermicompost preparation. The second largest component was non-degradable (20 % and 25 %) comprised of plastics while, proportion of inert material usually consisted of silt, debris, construction and demolition materials and was around 15.00 to 16.00 per cent. The biodegradable or organic fraction was highest due to practice of using fresh vegetables and fruits in the food system on daily basis. The higher organic content also necessitates frequent collection and removal of solid waste. Based on recyclability of solid waste, percentage of recyclable and non-recyclable solid waste in Hubballi-Dharwad was quite large at 284 t/day (71.00 %) and 116 t/day (29.00 %), respectively. Similarly, in Bengaluru the portion of recyclable (67.00 %) solid waste was more than the non-recyclable (33.00 %). Thus, it could be inferred that the corporations have greatest challenge of handling the degradable and recyclable wastes more scientifically which not only generate the income, employment substantially and also ensure safe disposal for a healthy environment.

1. **Extent of recycling of solid waste in Hubballi-Dharwad and Bengaluru**

The extent of recycling or processing of solid waste generated in the city is presented in Table 3. The processing facility in Hubballi-Dharwad was not buit to processes the entire quantity generated in city. The processing method followed in the twin cities was limited to vermicomposting with a processing capacity of only 10 t/day (2.50 %) and processing of waste was not on regular basis thus, most of the waste generated (97.50 %) in the city was dumped in two dumping yards located at Hubballi and Dharwad. The main reason being the lack of financial resources to have processing facility and other reason was that the solid waste was considered not a serious problem as yet. However, quantity of solid waste generated was managed by dumping in two open dump yards and considered to be most unscientific approach as against the holistic management approach.

The existing methods of waste processing in Bengaluru were vermicomposting and bio-methanation. Out of the 4,500 t of solid waste generated, about 1,000 t (22.22 %) and 300 t (6.67 %) of waste was processed through vermicomposting and bio-methanation, respectively. The remaining 3,200 t (71.11 %) of solid waste was landfilled in three land filling sites and in an year 11,96,481 t of waste is being accumulated in the land filling sites. BBMP was processing solid waste in three locations such as MSGP with a plant capacity of 500 t/day (11.11 %), KCDC and Mavallipura with a processing capacity 300 t/day (6.67 %). There were 12 bio-methanation plants with a capacity of 5 t/day (0.11 %) and vermicomposting was carried out by Karnataka Compost Development Corporation (KCDC) on commercial scale. The results were supported by the findings of Sequeira and Chandrashekar (2015) opined that the bio-degradable portion of solid waste can be processed by using eco-friendly technologies like vermicomposting and reported that in Mangaluru about 50 to 60 t/day of compost was prepared from household waste only and as a result less waste was found on the community dumping sites.

1. **Cost incurred in production of vermicompost from solid waste**

The cost and returns in vermicompost preparation using solid waste is indicated in the Tables 4 and 5. It is clear from the results that per tonne production cost was more in Bengaluru compared to Hubballi-Dharwad (C:\Users\user\Desktop\RUPEE.jpg 5,245.5/t). This was because of high composition of materials solid involved in the solid waste collected and quantity of solid waste required for per tonne vermicompost production was more due to its constituent composition which added to the cost to take solid waste raw material to the processing plant and segregate the required biodegradable material from it. The share of variable cost was 87.07 per cent and 90.10 per cent in Hubballi-Dharwad and Bengaluru. Of the total variable cost, expenditure on solid waste collection and earth worms was more and these two components together contributed 83.54 per cent in Hubballi-Dharwad and 82.75 per cent in Bengaluru.

Per tonne total cost of vermicompost production comprising of production cost and marketing cost were C:\Users\user\Desktop\RUPEE.jpg 5,500.55 and C:\Users\user\Desktop\RUPEE.jpg 6,665.08 per tonne in Hubballi-Dharwad and Bengaluru, respectively. The price realised per tonne of vermicompost was related more in Bengaluru than in twin city. This was due to superiority of the vermicompost produced in Bengaluru. The net returns realised after deduction of total cost from gross returns was C:\Users\user\Desktop\RUPEE.jpg 1,999.45 and C:\Users\user\Desktop\RUPEE.jpg 3,334.92, respectively in Hubballi-Dharwad and Bengaluru with a benefit cost ratio of 1.36 and 1.50. It could be concluded that production of vermicompost was found to be economically profitable in Bengaluru than in twin cities considering the net returns. The study on influence of municipal solid waste compost on soil properties and plant reestablishment by Civeira (2010) reported that application of compost has increased organic carbon, total nitrogen and exchangeable phosphorous. Thus, soil physical properties were found to be improved after municipal solid waste compost addition.

1. **Financial feasibility of vermicompost plants in Hubballi-Dharwad and Bengaluru**

To evaluate the feasibility of investment in vermicompost preparation, the final project evaluation criteria such as Net Present Value (NPV), Benefit Cost Ratio (BCR), Internal Rate of Return (IRR) and Pay Back Period (PBP) were employed.

The net present values were positive and highest at C:\Users\user\Desktop\RUPEE.jpg 98,867.31 and C:\Users\user\Desktop\RUPEE.jpg 1,99,827.14per tonne basis for the investment in vermicompost production in Hubballi-Dharwad and Bengaluru, respectively (Table 6) at 12 per cent discount rate. Thus, it could be concluded that investment in vermicompost preparation was economically feasible and financially sound in addition to its social acceptability. The higher magnitude of positive net present values as net cash flows considered advisable for a project to be sound and in this case might be attributed to the fact that the initial investment and maintenance cost in vermicompost preparation was lesser compared to returns realized.

The IRR criteria measure the rate of return that can be realized by the investment in vermicompost production. Hence, the IRR is an important tool and scores over other criteria, which do not consider the reinvestment opportunities. In the present study the IRR was found to be 26.12 per cent and 32.34 per cent respectively in Hubballi-Dharwad and Bengaluru, which was high compared to prevailing interest rates. Hence, it can be inferred that the investment in vermicompost production was found to be economically feasible, financially sound and highly profitable option for the corporations to start venture to convert waste into economically useful material.

The Benefit–Cost ratio criterion indicated the returns per rupee of investment in vermicompost preparation. The benefit–cost ratio in vermicompost preparation in Hubballi-Dharwad and Bengaluru were 1.50 and 2.04, respectively, indicating that for each rupee invested in vermicompost preparation yields 1.50 and 2.04 returns. Thus, it could be concluded that investment in these orchards was economically feasible and financially viable.

The Pay Back Period for vermicompost plant was 2.51 and 2.01 years, respectively in Hubballi-Dharwad and Bengaluru. This clearly indicated that 2.51 years and 2.01 years would require for getting back the initial investment. This could be attributed with fact that the initial investment itself was lower, besides higher rate of returns realized enabled early recovery of initial investment. Similar results were reported (Anon., 2007) in the study conducted on economics of vermicompost production in South Karnataka.

Thus, the financial feasibility as proved in the investment analysis not only enable to venture in to processing of large volume of degradable solid waste generated in the cities but also contribute towards mitigating the negative externalities/social costs that are contributed by accumulation of such solid waste over time and thereby contribute towards safe and healthy environment.

**Conclusion**

Municipal solid waste management is most crucial issue of urban management. The generation of solid waste is ever increasing with the increase in population. Handling of solid waste has become one of the major challenges in India in recent years as there is continuous increase in industrial growth resulted in increased variety and volume of solid waste. Thus, Indian cities are invariably filled with huge amounts of garbage and solid waste in open places and dwelling area. Major portion of solid waste is recyclable (biodegradable) and recycling of solid waste is found to be economically and financially feasible. Extent of recycling of solid waste in Hubballi-Dharwad and Bengaluru on a daily basis is only 10 t (out of 284 t) and 1,300 t (out of 3,015 t) accounted just 2.50 per cent and 28.89 per cent of total recyclable waste, respectively. Therefore, efforts should be made to processes the remaining recyclable portion of solid waste by adopting improved waste processing technologies like bio-methanation, waste to energy, palatalization (Refuse Derived Fuel) and incineration (reduction in volume of solid waste) in order to minimize the burden on landfill sites.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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**Table 1: Source wise generation of solid waste in the selected municipal corporations in the state**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ****Sl. No.**** | ****Sources of solid waste**** | ****HDMC**** | | | | ****BBMP**** | | | |
| ****Quantity (t/day)**** | | ****Percentage**** | | ****Quantity****  ****(t/day)**** | | ****Percentage**** | |
| 1 | Household | 220 | | 55.00 | | 2,520 | | 56.00 | |
| 2 | Hotels | 65 | | 17.00 | | 585 | | 13.00 | |
| 3 | Market area | 34 | | 8.00 | | 360 | | 8.00 | |
| 4 | Commercial area | 36 | | 9.00 | | 405 | | 9.00 | |
| 5 | Institutional area | 3 | | 1.00 | | 135 | | 3.00 | |
| 6 | Industries | 12 | | 3.00 | | 225 | | 5.00 | |
| 7 | Debris | 20 | | 5.00 | | 225 | | 5.00 | |
| 8 | Miscellaneous | 10 | | 3.00 | | 45 | | 1.00 | |
|  | **Total** | | **400** | | **100.00** | | **4,500** | | **100.00** |

**Source: BBMP office (**[**http://bbmp.gov.in/en/web/guest/solid-waste-management**](http://bbmp.gov.in/en/web/guest/solid-waste-management)**) and HDMC office**

**Table 2: Classification of municipal and household solid waste**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sl. No.** | **Particulars** | **Hubballi-Dharwad** | | | | **Bengaluru** | | | |
| **HDMC** | | **Households** | | **BBMP** | | **Households** | |
| **Quantity (t/day)** | **%** | **Quantity**  **(kg)** | **%** | **Quantity (t/day)** | **%** | **Quantity**  **(kg)** | **%** |
| **Based on degradability** | | | | | | | | | |
| 1 | Degradable | 260 | 65.00 | 0.96 | 71.00 | 2700 | 60.00 | 1.03 | 68.00 |
| 2 | Non- degradable | 80 | 20.00 | 0.26 | 19.00 | 1125 | 25.00 | 0.36 | 24.00 |
| 3 | Inerts (debris) | 60 | 15.00 | 0.15 | 10.00 | 675 | 15.00 | 0.12 | 8.00 |
| **Total** | | **400** | **100.00** | **1.35** | **100.00** | **4,500** | **100.00** | **1.51** | **100.00** |
| Based on recyclability | | | | | | | | | |
| 1 | Recyclable | 284 | 71.00 | 1.01 | 75.00 | 3015 | 67.00 | 1.07 | 71.00 |
| 2 | Non-recyclable | 116 | 29.00 | 0.34 | 25.00 | 1485 | 33.00 | 0.44 | 29.00 |
| **Total** | | **400** | **100.00** | **1.35** | **100.00** | **4,500** | **100.00** | **1.51** | **100.00** |

**Source: BBMP office (**[**http://bbmp.gov.in/en/web/guest/solid-waste-management**](http://bbmp.gov.in/en/web/guest/solid-waste-management)**) and HDMC office**

**Table 3: Extent of recycling of solid waste in the selected municipal corporations**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sl. No.** | **Processing facility** | **Quantity processed (t/day)** | **Percentage** | **Quantity processed (t/year)** | **Percentage** |
| **Hubbli-Dharwad twin cities (HDMC)** | | | | | |
| 1. | Vermicomposting | 10 | 2.50 | 5,277 | 3.34 |
| 2. | Dumping | 390 | 97.50 | 1,52,723 | 96.66 |
| **Total** | | **400** | **100.00** | **158000** | **100.00** |
|
| **Bengaluru city (BBMP)** | | | | | |
| 1 | Vermicomposting | 1,000 | 22.22 | 4,35,489 | 24.43 |
| 2 | Bio-methanation | 300 | 6.67 | 1,50,630 | 8.45 |
| 3 | Landfilling | 3,200 | 71.11 | 11,96,481 | 67.12 |
| **Total** | | **4,500** | **100.00** | **17,82,600** | **100.00** |

**Source: BBMP office (**[**http://bbmp.gov.in/en/web/guest/solid-waste-management**](http://bbmp.gov.in/en/web/guest/solid-waste-management)**) and HDMC office**

**Table 4: Cost incurred in production of vermicompost from solid waste in selected municipal corporations (**C:\Users\user\Desktop\RUPEE.jpg**/t)**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sl. No** | **Particulars** | **Units** | **Hubballi-Dharwad twin cities** | | | **Bengaluru city** | | |
| **Quantity** | **Value** | **Percentage** | **Quantity** | **Value** | **Percentage** |
| 1 | Variable cost |  |  |  |  |  |  |  |
| I. | Raw material cost | C:\Users\user\Desktop\RUPEE.jpg |  | 4,382 | 83.54 |  | 5,291.68 | 82.75 |
|  | 1. Solid waste | t | 6.12 | 2,312 | 44.08 | 7.44 | 2,881.68 | 45.06 |
|  | 2. Earthworm | kg | 4.14 | 2,070 | 39.46 | 4.82 | 2,410.00 | 37.69 |
| II. | Labour cost |  | 4.17 | 307.52 | 5.86 | 3.04 | 258.52 | 4.04 |
|  | 1. Pit filling | Md | 1.12 | 91.81 | 1.75 | 0.92 | 81.12 | 1.27 |
|  | 2. Worm separation | Md | 1.08 | 73.45 | 1.40 | 0.58 | 68.57 | 1.07 |
|  | 3. Watering | Md | 1.01 | 71.17 | 1.36 | 0.66 | 55.52 | 0.87 |
|  | 4. Sieving | Md | 0.96 | 71.09 | 1.36 | 0.88 | 53.31 | 0.83 |
| III. | Interest on working capital |  |  | 36.90 | 0.70 |  | 31.02 | 0.49 |
| **IV.** | **Total Variable cost (I+II+III)** | C:\Users\user\Desktop\RUPEE.jpg |  | **4,726.42** | **90.10** |  | **5,581.22** | **87.27** |
| 2. | Fixed costs |  |  |  |  |  |  |  |
|  | 1. Land rent | C:\Users\user\Desktop\RUPEE.jpg |  | 236.34 | 4.51 |  | 436.67 | 6.83 |
|  | 2. Working shed | C:\Users\user\Desktop\RUPEE.jpg |  | 154.34 | 2.94 |  | 191.43 | 2.99 |
|  | 3. Tools and Machineries | C:\Users\user\Desktop\RUPEE.jpg |  | 128.45 | 2.45 |  | 185.76 | 2.90 |
| **V.** | **Total Fixed cost** | C:\Users\user\Desktop\RUPEE.jpg |  | **519.13** | **9.90** |  | **813.86** | **12.73** |
| **VI.** | **Total production cost (IV+V)** | C:\Users\user\Desktop\RUPEE.jpg |  | **5,245.5** | **100.00** |  | **6,395.10** | **100.00** |

**Source:** Researcher calculation using data collected from BBMP and HDMC office

**Table 5: Costs and returns from production and sale of vermicompost in the selected municipal corporation**

**(**C:\Users\user\Desktop\RUPEE.jpg**/t)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl. No.** | **Particulars** | **Hubballi-Dharwad twin cities** | **Bengaluru city** |
| **Value** | **Value** |
| 1 | Production cost (A) | 5,245.55 | 6,395.08 |
| 2 | Marketing cost (B) | 255 | 270 |
|  | i. Cost of plastic bags | 50 | 60 |
|  | ii. Packing cost | 30 | 20 |
|  | iii. Transportation cost | 120 | 150 |
|  | iv. Loading & unloading | 55 | 40 |
| 3 | Total cost (A+B) | 5,500.55 | 6,665.08 |
| 4 | Gross returns | 7,500 | 10,000 |
| 5 | Net returns per ton [C-B-A] | 1,999.45 | 3,334.92 |
| 6 | Benefit cost ratio | 1.36 | 1.50 |

**Source:** Researcher calculation using data collected from BBMP and HDMC office

**Table 6: Financial feasibility of compost plants in selected municipal corporations**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl. No.** | **Particulars** | **Hubballi-Dharwad twin cities** | **Bengaluru city** |
| **Value** | **Value** |
| 1 | Net present value (@ 12% discount rate) | 98,867.31 | 1,99,827.14 |
| 2 | Benefit cost ratio | 1.50 | 2.04 |
| 3 | Internal rate of return (%) | 26.12 | 32.34 |
| 4 | Payback period (Years) | 2.51 | 2.01 |

**Source:** Researcher calculation using data collected from BBMP and HDMC office