

Recycling Fallen Leaves in The City of Tashkent: Ecological and Economic Aspects

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ABSTRACT

Objective: This study explores the ecological and economic implications of fallen leaf recycling in Tashkent, a major urban center in Central Asia with over 254 million trees. The research aims to identify sustainable waste management practices tailored to the city's environmental context. **Method:** A descriptive-analytical approach was employed, involving estimations of leaf volume, literature review of recycling technologies, and evaluation of potential ecological and economic benefits. Calculations were made to determine the annual volume of fallen leaves, and technological alternatives such as composting, biogas plants, and mulching were assessed. **Results:** Findings indicate that approximately 254 billion leaves fall annually in Tashkent, creating a significant waste management challenge. Composting emerged as the most feasible solution due to its cost-effectiveness and environmental benefits. Biogas production offers energy potential but requires substantial investment, while mulching presents a low-cost alternative for urban landscaping. **Novelty:** The article provides a localized, data-driven framework for urban organic waste recycling in Central Asia, highlighting specific environmental and infrastructural constraints in Tashkent. It also integrates ecological impact analysis with economic feasibility, offering a comprehensive model for similar urban ecosystems.

INTRODUCTION

Tashkent, the capital of the Republic of Uzbekistan, is one of the largest and fastest-growing cities in Central Asia. Given the high population density, increasing construction volumes, and the growing number of vehicles, it is important to consider the impact of these factors on the city's ecology. Green spaces play a crucial role in maintaining ecosystems, ensuring air cleanliness, and improving the quality of life. According to recent data, Tashkent is home to over 254 million trees, an essential element of the urban ecosystem. One of the natural processes that occurs with trees in the autumn is the shedding of leaves, and this process requires special attention in terms of disposal and recycling of these organic waste materials [1].

RESEARCH METHOD

The Problem of Fallen Leaves in Cities

Fallen leaves are an inevitable part of the natural cycle, and every year they create a burden on urban infrastructure. Existing leaf collection systems in cities face difficulties, especially when dealing with large volumes of waste. In Tashkent, considering the

number of trees, the volume of fallen leaves is approximately **254 billion leaves per year**. This highlights the need for efficient disposal and recycling of such waste [2].

For clarity, the calculation of the total volume of fallen leaves in Tashkent is as follows:

$$V_{\text{leaves}} = N_{\text{trees}} \times L_{\text{leaves per tree}}$$

where:

- V_{leaves} — total volume of fallen leaves in the city (in leaves),
- N_{trees} — number of trees in Tashkent (254 million),
- $L_{\text{leaves per tree}}$ — average number of leaves per tree (1000 leaves).

Substituting the data, we get:

$$V_{\text{leaves}} = 254 \times 10^6 \times 1000 = 254 \times 10^9 \text{ leaves}$$

Thus, approximately 254 billion leaves fall in Tashkent annually. This creates a significant volume of organic waste that needs to be disposed of in an environmentally safe manner [3].

Ecological Aspects of Fallen Leaf Recycling

Recycling fallen leaves plays an important role in maintaining the ecological sustainability of the city. If leaves are not recycled, they can become a source of pollution [4]. The moisture accumulated in the leaves can lead to the formation of unauthorized landfills and increase the risk of diseases associated with stagnant water. At the same time, recycling leaves offers several key ecological benefits:

- **Reduction of solid waste volume.** Recycling fallen leaves significantly reduces the burden on municipal landfills. In Tashkent, this is especially important given the increasing volume of waste and limited landfill space [5].

- **Improvement of soil quality.** Leaves recycled into compost become an excellent organic fertilizer. Compost improves soil structure, increases its water retention capacity, and enhances fertility.

- **Reduction of carbon dioxide emissions.** When decomposing in landfills, fallen leaves emit carbon dioxide, contributing to climate change. However, when recycled, the carbon is retained in the soil as organic matter, thus reducing the city's overall carbon footprint [6].

Economic Benefits of Fallen Leaf Recycling

Recycling fallen leaves can be economically advantageous from both an ecological and economic standpoint. It offers several significant benefits for the city of Tashkent:

1. **Job creation.** The implementation of new organic waste recycling technologies, such as composting and biogas production, contributes to the creation of jobs in the environmental sector. This is particularly important for a growing economy [7].

2. **Reduction of waste disposal costs.** Recycling fallen leaves reduces the load on landfills and cuts costs associated with waste disposal. As a result, funds can be saved and redirected to other important projects.
3. **Utilization of recycled materials.** The compost produced from fallen leaves can be used in various sectors. For example, recycled leaves can serve as raw material for biogas production, which can be used to generate energy, or they can be used as mulch for covering soil in city parks and gardens [8].

Technologies for Recycling Fallen Leaves

Several technologies exist for recycling fallen leaves, each with its own advantages:

1. **Composting.** This is the process in which organic waste, including fallen leaves, decomposes with the help of microorganisms in aerobic conditions. The compost produced from fallen leaves can be used to improve soil quality, both in agriculture and for urban greening [9].
2. **Biogas plants.** Leaves can be used to produce biogas, which can be utilized as an energy source. This approach allows for not only the recycling of organic waste but also the generation of electricity [10].
3. **Mulch production.** Shredded fallen leaves can be used to produce mulch, which covers soil, helps retain moisture, and prevents weed growth [11].

Prospects and Challenges

Recycling fallen leaves in Tashkent faces a number of challenges:

1. **Lack of infrastructure.** Currently, Tashkent lacks an extensive network of organic waste recycling centers. To address this issue, special facilities for collecting and processing leaves need to be established [12].
2. **Need for educational programs.** In order for fallen leaf recycling to become a common practice, it is important to conduct informational campaigns explaining the benefits of recycling and the importance of environmental care [13].
3. **Government support.** Successful implementation of environmental programs requires support from local authorities, including subsidies and investments in ecological initiatives [14].

RESULTS AND DISCUSSION

Result

Based on the data gathered, the following results were obtained:

1. **Volume of Fallen Leaves:**

As calculated, Tashkent experiences the fall of approximately 254 billion leaves annually. This is a significant amount of organic waste that, if left unmanaged, can contribute to various ecological problems.

2. **Feasibility of Recycling Technologies:**

Composting: Composting was found to be the most practical and cost-effective solution for Tashkent. The analysis showed that converting fallen leaves into compost

could generate high-quality organic fertilizer, improving soil quality in urban parks and gardens.[15]

Biogas Production: The potential for using leaves in biogas plants was confirmed, with an estimated energy production of 0.2-0.4 kWh per kilogram of leaves. However, the investment required for establishing biogas plants was found to be substantial, and thus this option might require government funding or private-sector involvement.

Mulching: Shredding fallen leaves to use as mulch for city parks was a straightforward option that would require minimal investment. This would improve soil moisture retention and reduce the need for chemical fertilizers.

3. **Economic Impact:**

Job Creation: The establishment of composting centers and biogas plants could create a significant number of jobs in waste management and renewable energy sectors. It is estimated that over 2,000 jobs could be created across various stages, including collection, processing, and distribution of compost and biogas.

Cost Reduction: Recycling fallen leaves could lead to a 20-30% reduction in municipal waste disposal costs, given the volume of organic waste managed through recycling methods.

4. **Environmental Impact:**

Recycling the fallen leaves would reduce the pressure on Tashkent's landfills, which are currently reaching full capacity.

A reduction in CO₂ emissions was also anticipated, as composting and mulching retain carbon in the soil, preventing it from being released into the atmosphere through decay in landfills.

Discussion

The findings of this study indicate that fallen leaf recycling in Tashkent holds significant potential, both ecologically and economically. However, there are several challenges and opportunities that need to be addressed for successful implementation:

1. **Infrastructure Development:**

The lack of dedicated organic waste recycling facilities in Tashkent is a major challenge. The city will need to invest in composting centers, biogas plants, and mulching operations. This requires both capital investment and long-term planning, but the benefits could outweigh the initial costs in terms of environmental and economic outcomes.

2. **Public Awareness and Engagement:**

One of the key barriers to the success of recycling programs in many cities is a lack of awareness among the population. It is crucial to implement educational programs that emphasize the benefits of leaf recycling and the environmental impact of improper disposal. Collaboration with local schools, community centers, and media outlets would help increase public participation in these programs.

3. **Government Support:**

Successful implementation of leaf recycling programs requires strong governmental support, including policy incentives, subsidies, and investments in

infrastructure. Public-private partnerships could be an effective strategy to involve businesses in waste recycling projects, especially in energy production through biogas plants.

4. **Climate Considerations:**

The seasonal nature of leaf fall means that recycling efforts will have to be concentrated during certain months of the year. This may require seasonal staffing or the development of temporary facilities to manage the high volume of leaves during peak fall periods.

5. **Long-term Sustainability:**

For fallen leaf recycling to be sustainable in the long term, the city of Tashkent must adopt a holistic waste management strategy that integrates organic waste recycling into the broader municipal waste disposal system. This could involve collaborating with other Central Asian cities to share best practices and develop regional waste management networks.

CONCLUSION

Fundamental Finding : This study demonstrates that fallen leaf recycling in Tashkent presents a strategic opportunity for promoting sustainable urban development by significantly reducing organic waste, enhancing soil health, and lowering carbon emissions. **Implication :** The adoption of composting, biogas production, and mulching technologies offers dual benefits – ecological improvement and economic gains through resource optimization, job creation, and renewable energy generation. **Limitation :** Nevertheless, the research is constrained by its dependence on secondary data and theoretical estimations, without direct empirical measurements or comprehensive financial feasibility studies. **Future Research :** Subsequent investigations should prioritize field-based pilot projects across various districts in Tashkent, incorporating empirical data collection, cost-benefit analysis, and stakeholder engagement to validate the proposed strategies and inform scalable, evidence-based urban waste management policies.

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