

# Recycling and Utilization of Garden Waste

Huiling Zhang<sup>1, a</sup>, Chaocheng Zheng<sup>1, b</sup>, Huiling Zhang<sup>1, b</sup>, Liulao Lv<sup>1, b</sup> and Zhihui Luo<sup>1, d</sup>

<sup>1</sup>Nanjing Vocational Institute of Transport Technology, Nanjing 211188, China

<sup>a</sup>2839649342@qq.com, <sup>b</sup>zccnau@126.com, <sup>c</sup>1908458926@qq.com, <sup>d</sup>3020465389@qq.com

**Abstract:** Garden waste mainly refers to the fallen leaves, branches, tree trimmings, shrub trimmings, lawn trimmings, and other plant residues generated during the natural or maintenance process of garden plants. If garden waste is treated as general solid waste landfill, cost, as well as environmental pressure will be increased. Hence, resource utilization of garden waste can reduce carbon emissions and significantly improve the quality of urban environmental construction. Based on this, this article focuses on the current status of garden waste treatment and utilization methods to analyze problems existing in the resource utilization of garden waste so as to look forward to the prospects of garden waste recycling and its contribution to the ecological civilization development of the garden greening industry.

**Keywords:** Garden waste, Recycling and utilization, Handling method.

## 1. Introduction

According to the "State Bulletin of China's Land Greening" released by the Office of the National Greening Commission, the data on green space, green space rate, and per capita park green space area in urban built-up areas are constantly increasing, and the waste generated by greening is also increasing. According to the concept of conservation-oriented urban landscaping in the "Opinions on Building Conservation-oriented Urban Landscaping" issued by the Ministry of Housing and Urban Rural Development of the People's Republic of China, the construction of conservation-oriented urban landscaping should follow the principle of natural and social resource circulation and rational utilization to maximize the savings of various resources in various aspects of urban landscaping planning, design, construction, maintenance and management, and healthy and sustainable development, improve resource utilization efficiency, reduce resource consumption and waste so as to achieve maximum ecological, social, and economic benefits.

## 2. Significance of Recycling and Utilization of Garden Greening Waste

The recycling and utilization of garden greening waste is necessary for the construction of ecological civilization. The vigorous development of China's landscaping and greening industry has made important contributions to urban sustainable development. How to efficiently recycle and utilize garden plant waste, make good use of "valuable waste", achieve coordinated and unified sustainable development, and leave a beautiful environment for sustainable development for future generations has become an important goal of China's development of energy-saving landscaping and greening.

### 2.1. Ecological benefits of landscape waste recycling and utilization

The recycling and utilization of garden waste can bring significant ecological benefits. Landscape greening waste is an important organic resource that undergoes nutrient cycling

in the ecosystem. Through the scientific recycling and utilization of garden and greening waste, it is possible to "turn waste into treasure" in transforming waste into resource utilization products such as organic fertilizers, organic coverings, and biomass fuels, and utilizing garden waste recycling to feed back the ecological environment.

### 2.2. Economic benefits of landscape waste recycling and utilization

Recycling and utilization of garden waste is of high economic value. Taking 1 ton of garden plant waste as an example, without considering the cost of the collection process, the landfill treatment fee is about 150 yuan. If it is made into organic fertilizer, the market price for each ton of organic fertilizer is 600 yuan, and there is a high demand for organic fertilizer in the market.

### 2.3. Social Benefits of Landscape Waste Recycling and Utilization

Recycling and utilization of garden waste can bring positive social benefits. Efficient resource utilization of garden greening waste is in line with the concept of ecological civilization construction and can enhance public awareness of ecological and environmental protection as well. It can not only effectively reduce adverse impacts on the environment and control resource waste, but also promote resource recycling within the landscaping industry, expand and strengthen green and low-carbon industries, and ultimately form a green industry chain, which is of great significance for developing transformation, promoting green development, and promoting efficient economic growth.

## 3. Current Situation of Landscape Waste Recycling at Home and Abroad

### 3.1. Current Situation of Reuse of Landscape Greening Waste in Foreign Countries

In 1994, Environmental Protection Agency of the United States issued the EPA530-R-94-003 law, which explicitly prohibits incineration and promotes scientific recycling. Under the norms of this law, the United States has gradually

formed a collection of raw material supply, collection, processing, equipment manufacturing, production. The integrated sales and recycling industry of landscaping waste has an annual output value of up to 60 billion US dollars. At present, some developed countries have formed advanced and complete waste treatment systems, which have been reflected in policy support and technological innovation for landscaping waste. On the one hand, in the development of composting technology, biomass treatment technology, energy utilization and other technologies, promote the resource recovery and utilization of garden waste; On the other hand, by introducing corresponding laws and regulations, policy basis is provided for the recycling and utilization of landscaping waste.

In the United States, garden waste has become the second largest urban solid organic waste after newspapers. The collection and treatment of garden waste is not only a problem for the garden department itself. The Environmental Protection Agency of the United States regards garden waste as an important component of urban solid waste, ensuring the land use of garden waste from the perspective of environmental legislation. As early as the late 1980s, the governments of Florida, Minnesota, Ohio, and other states banned the incineration or landfill of organic garden waste. Subsequently, more than 20 states in the United States have enacted similar laws to ensure the effective implementation of land use of garden waste from a policy and regulatory perspective. In addition, many states also stipulate that when waste composting materials meet the quality requirements of

soil improvement materials, government departments must purchase or use these waste composting materials, providing policy guarantees for the land use of waste composting materials from a legislative perspective. In order to improve the composting and land use efficiency of garden waste, many states have also established funds or formulated various policies and plans to guide the composting utilization of garden waste, such as establishing specialized composting associations to guide the composting of organic waste such as gardens; Provide loans to manufacturers operating garden waste to purchase machinery; It is stipulated that fees should be levied for collecting garden waste to subsidize the operating costs of manufacturers; Estimate the number of different residents and the production of garden waste to determine the scale of composting manufacturers, operating costs, and etc.

Due to policy and funding guarantees, the proportion of garden waste used for composting is increasing year by year in the United States. The proportion of garden waste used for composting in the United States increased fourfold from 12.4% in 1990 to 62.0% in 2005 (Table 1). The number of institutions engaged in garden waste treatment has also increased accordingly. In 1990, there were approximately 2200 domestic institutions in the United States, with an annual composting output of approximately 42000 tons; By 1992, it had increased to 3000 households; In 1995, it increased to 3300 households; By 2000, it had reached 3800 households, and the amount of garden waste composting was also increasing.

**Table 1.** The amount of garden waste and the proportion of composting utilization in different years in the United States

Project	1990	1994	1995	2001	2005
Total amount of garden waste/	3500	3060	2980	2800	3222
Compost utilization ratio/%	12.4	22.9	30.3	56.4	30.3

Different states in the United States have different regulations on the composition of garden waste, and generally each state's Environmental Protection Agency has corresponding regulations on the sources of ingredients for collecting garden waste in their respective regions. According to Florida regulations, only pruned leaves, weeds, lawns, and small shrubs, as well as pruned branches of palm trees, and other garden waste are collected. It is prohibited to mix plastic bags, stones, sand and soil, large garbage, large branches, branches, and treated wood products during collection. The city of Los Angeles stipulates that the collection of garden waste does not include stones, wood, garden decorations, or shattered flower pots; Due to the inability of plastic bags and metal wires to decompose during the composting process, it is stipulated that bags for collecting garden waste cannot be used with plastic bags, nor can metal wires be used to tie branches. However, some states allow the collection of raw vegetables, vegetable peels, and garden waste being together.

The composting process of garden waste in the United States is generally divided into three stages: pre-treatment, fermentation stacking, and post-processing. There are strict regulations and corresponding technical guidance specifications in different stages and processes, providing technical support for controlling the quality of composting.

### 3.2. Current Situation of Reuse of Landscape Greening Waste in China

In March 2021, the National Greening Commission

released the "2020 China Land Greening Status Bulletin", which showed that there were 441 cities under the construction of national forest cities, with a per capita park green area of 14.8 square meters. The waste generated by urban greening increased sharply at an annual rate of 10% to 20%. The main disposal methods for landscaping waste include incineration, landfill, disposal, and a small amount of resource utilization. Therefore, landscaping waste has not yet been well developed and utilized in major cities in China. About 90% of landscaping waste is landfilled or incinerated with household waste, which not only wastes land resources but also easily pollutes the environment, making it unable to meet the requirements of sustainable development.

The technology and equipment for treating garden and greening waste in China are relatively backward, especially the long-term dependence of large crushers on imports. The domestic equipment is mainly small crushers, most of which are imitations of foreign products and lack independent intellectual property rights. At the same time, the market lacks suitable garden and green waste treatment equipment for China's national conditions. Moreover, the lack of policies, laws, regulations, and technical standards related to the disposal of landscaping waste has led to lax supervision and a high degree of arbitrariness in disposal.

In 2002, Guangzhou established a garden substrate factory to convert garden greening waste such as dead branches and fallen leaves into plant growth substrate soil.

In 2006, Beijing issued policies to establish centralized disposal bases for garden and green waste in various districts and counties, and explored and developed various mature resource reuse products.

In 2008, Shanghai incorporated garden and green waste into the urban organic waste series and provided policy support.

In 2019, Suzhou Municipal Bureau of Landscape Architecture issued a notice on the Implementation Measures for the Classification and Disposal of Urban Landscape Garbage in Suzhou (Trial).

In 2020, China Energy Equipment independently developed the first domestic garden waste crushing vehicle and proposed a new integrated mode of on-site crushing, collection and transportation of garden waste. Hence, Zhongneng Equipment has innovated its equipment and model, proposing a new ecological development model for the resource utilization of landscaping waste that is in line with China's national conditions.



Figure 1. Zhongneng Equipment

Zhongneng model follows the principles of "government guidance, enterprise leadership, and market operation" and is based on technological innovation. It utilizes the domestically developed first blue brand garden waste crushing vehicle, which operates in a mobile on-site mode and radiates in a grid manner, covering all areas where garden and green waste is generated. Temporary collection and storage points are set up, and a resource based comprehensive disposal center is established. Combined with the Internet of Things information management platform, the processing process can be simplified. Reduce labor intensity, reduce transportation costs, and build a new ecological model for landscaping waste.

1. Front end collection: Grid layout, setting up multiple temporary storage points

Garden and green waste has the characteristics of scattered production areas, strong fluctuation in production, and difficulty in collection. By setting up temporary storage points for garden and green waste in each residential area, the trimmed garden and green waste is temporarily stored. The storage points are set with capacity thresholds. After reaching the threshold, orders can be placed through the reservation system, and garden waste crushing trucks can be notified to come to the temporary storage points for on-site crushing, which can simplify the operation process and improve work

efficiency, Reduce transportation costs.

2. Mid range cleaning and transportation: door-to-door crushing, reduced capacity transportation - garden waste crushing truck QVG200

The garden waste crushing vehicle is a specialized mobile crushing operation vehicle for garden and green waste that China Energy Equipment specializes in meeting the requirements of China's road traffic environment. From the perspective of reducing the capacity of garden and green waste and reducing transportation costs, it integrates collection, crushing, and transportation. The vehicle has stronger mobility and more convenient mobile operations. It can be widely used for the collection, transportation, and crushing of garden greening waste on both sides of various scenic spots, parks, schools, residential areas, and municipal roads.

3. Backend resource utilization: Resource utilization comprehensive processing center

Unified resource utilization is carried out for the comprehensive treatment center of landscaping waste, such as biomass power generation, soil cover, organic composting, biomass particles, biomass charcoal, etc. The center has functions such as crushing, reprocessing, storage, transfer, and resource utilization.

4. Internet of Things cloud platform: big data intelligent operation ecosystem

By utilizing the Global Positioning System (GPS) and the Internet, intelligent identification, positioning, tracking, monitoring, and management of equipment can be achieved, enabling remote, dynamic, and all-weather connectivity between equipment, operators, service engineers, and manufacturing plants. Conduct big data analysis on job information, equipment status, fault information, etc., and create an intelligent operation ecosystem for landscaping waste.

## 4. Main Treatment Methods for Garden Greening Waste

At present, the modes of recycling, treatment and utilization of landscaping waste are mainly divided into traditional landfill and incineration, and resource utilization. Resource utilization is also divided into organic composting, organic covering, and biomass energy modes.

### 4.1. Traditional treatment methods for landfill and incineration

Landfill and incineration are the main disposal modes of garden waste in China. This traditional disposal method takes short time and is simple, but it can lead to resource loss, secondary pollution problems such as occupying landfill sites and generating smoke on the ecological environment. It not only causes environmental pollution but also leads to resource waste. This method has been abandoned by developed countries and is not in line with China's ecological civilization construction and development strategy. According to the needs of ecological civilization construction, with the gradual improvement of policies and regulations on garbage classification and utilization, as well as the continuous development of treatment technology, landfill and incineration treatment methods will be gradually replaced by other treatment methods.

## 4.2. Composting treatment of garden waste

Biological composting, as a harmless treatment method for landscaping waste, has gradually replaced the traditional landfill incineration disposal method and is becoming increasingly mature. With the development of the industry and policy guidance, various methods and regulations for composting treatment of landscaping waste have also emerged, such as the "Technical Specification for Disposal and Application of Greening Plant Waste" (LY/T 2316-2014), the "Beijing Municipal Specification for Resource Utilization of Landscaping Waste" (DB11/T 1512-2018) Shanghai's "Technical Specifications for the Disposal of Greening Plant Waste" (DB31/T 404-2009) and other regulations require that green waste be crushed and used as compost, organic fertilizer, and cultivation substrate.

## 4.3. Garden waste as organic cover

In recent years, the use of garden waste as organic cover has also been one of the treatment methods for the recycling and utilization of garden waste. The production of organic coverings in China is developing rapidly as an emerging environmental protection industry. Organic mulch not only enriches landscape colors and has a beautifying effect, but also maintains soil fertility, inhibits weed growth, and increases soil porosity.

## 4.4. Garden waste as biomass energy

Garden waste has a high calorific value, and if traditional incineration is used, the energy utilization rate is less than 10%; If used as biomass energy, the energy utilization rate will be greatly improved. Under the guidance of government policies, biomass energy has received widespread attention from all sectors of society: Fangshan in Beijing has established a biomass energy centralized heating demonstration project to promote the recycling and utilization of garden waste; Chongqing collects approximately 160 tons of garden waste and reserves it for the production of solid fuels in the future.

# 5. Existing Problems and Development Trends in The Recycling and Utilization of Garden Waste

## 5.1. The issue of disposal methods for garden waste

At present, most gardens do not have garden waste disposal centers, or the disposal volume cannot meet the demand. The garden maintenance staff do not have a clear sense of classification of garden waste. During the collection process, various green waste is uniformly packaged, and the disposal center causes damage to the disposal machine during processing and crushing, resulting in a huge waste of fuel for the shredder and increasing the processing cost. At the same time, it will also lead to uneven quality of garden waste products produced, and the stability of compost product quality is not guaranteed.

## 5.2. Collection, transportation, and crushing of garden waste

The collection and transportation of garden waste needs to be controlled from the source and fixed collection points should be set up. The high moisture content of garden waste results in low crushing efficiency of existing garden waste

crushers. If a drying device for garden waste is added in advance, the crushing efficiency can be improved. At the same time, adopting a multi-level utilization mode based on the crushed particle size can achieve high value and full utilization of garden waste.

## 5.3. Site selection for disposal of landscaping waste

The site selection and layout of the garden greening waste disposal center are also important considerations. The disposal process of landscaping waste can bring certain dust and noise pollution. How to minimize transportation costs while eliminating pollution, safety hazards, and energy conservation and emission reduction is an important issue that needs to be considered in the site selection process.

## 5.4. Urgent Policy and Financial Support

The resource utilization of garden greening waste involves multiple departments such as urban management, housing construction, planning, and transportation management. It requires government coordination, policy support from all levels of departments, establishment and improvement of household waste classification work, improvement of the collection, transportation, and treatment system of garden greening plant waste, and the development of corresponding laws, regulations, and series of standards to guide and regulate the resource utilization of garden waste. Measures for the Classification and Management of Domestic Waste in Xiamen Special Economic Zone, Technical Regulations for Composting of Garden and Greening Waste, and Practical Work on the Classification and Disposal of Urban Garden and Greening Waste in Suzhou City

Policy norms and plans such as the Implementation Measures (Trial) and the Development Plan for the Resource Utilization and Utilization of Garden Greening Waste provide a basis for the recycling of garden waste. The lack of project funding subsidies is also an important reason for the decline in the competitiveness of the landscaping waste resource utilization industry. Establishing special funds to subsidize projects for the resource utilization of garden waste will contribute to the development of the resource utilization of garden waste.

# 6. Summary

In summary, from the perspective of ecological civilization construction, the recycling and utilization of garden plant waste meets the requirements of green circular economy and energy-saving ecological development while from the perspective of market demand, with the development of the greening industry, the demand for products for the recycling of garden plant waste in the market will be increasing with broad development prospects.

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