

Adaptive landscape gardening in a metropolis

Elena Efimova^{1,*}, and *Svetlana Ponomareva*²

¹Ural State Economic University, Institute of Economics, Ekaterinburg, Russia

²Russian State Vocational-Pedagogical University, Ekaterinburg, Russia

Abstract. The article focuses on a solution to the quality-of-life issues, public health by using of new forms of adaptive gardening in the landscape of a large city. Reasoning and calculations of the efficiency for an alternative method of growing medicinal plants were made. **Keywords:** biotechnology, vertical gardening, modular beds, hill-shaped beds, economic efficiency.

1 Introduction

The quality of life in large Russian cities is assessed using various indicators and methods. Our attention was attracted by several ratings formed both on the basis of sociological research and on the assessment of objective criteria, which, along with indicators of GDP dynamics and population welfare growth, take into account those aspects of well-being that people really focus on - accessibility of health and education, real incomes of families, safety and quality of the urban environment, etc.

One of them is represented by the Financial University under the Government of the Russian Federation [<http://www.fa.ru/Pages/Home.aspx>], the methodology of the other was developed by VEB.The Russian Federation together with PwC consulting company and RANEPa under the Russian President in cooperation with the Agency for Strategic Initiatives (ASI) [<https://citylifeindex.ru/>]. Both ratings demonstrate that the quality of life in large cities of Russia is becoming primary in relation to economic growth. There is a transformation of priorities in politics and consciousness: the idea of human-centricity is being asserted, when the activities of the authorities in the country and in the regions should be aimed at satisfaction with the quality of life in a particular territory.

2 Materials and Methods

Indicators of the ecological environment state such as air and water quality, problems of waste removal and disposal are the best in cities where a historically formed garden landscaping is maintained, or park and walking areas are being created again, house territories are being landscaped, comprehensive measures are being taken to popularize adaptive forms of gardening and agrobiotechnologies in large metropolises.

Reflecting on the problem of increasing the effectiveness of techniques, forms and methods used in adaptive landscape gardening, we came up with the idea of including

*Corresponding author: levstrelkov@mail.ru

plants in urban plantings that can qualitatively affect the air state. It is about the so-called «live pharmacies» - medicinal plants containing biologically active substances that can be used for therapeutic and prophylactic purposes when including ornamental plants in compositions or independently be part of flowerbeds. Furthermore we became interested in ways that could lead to an increase in the useful area of land resources used for urban flower beds. In dense areas of a modern megalopolis, we consider qualitative and quantitative changes in the agricultural landscape to be relevant. The current situation forces researchers to look for new farming methods, to apply agrobiotechnologies more and more widely. At the moment, the method of vertical gardening is innovative.

3 Results and Discussion

The vertical arrangement of green spaces is not new and unique. This method of gardening was used by our distant ancestors for about 600 years BC. In Ancient Babylon, one of the 7 wonders of the world was erected – the Hanging Gardens of Babylon [7]. It should be noted that at that time vertical gardening was used only for decorative purposes and was not tied to gardening in order to obtain a socio-economic effect.

At the moment there are two types of vertical gardening in order to harvest on expediently used areas:

- 1) using natural materials;
- 2) using synthetic materials.

The first type is characterized by the use of natural ingredients: wood, bark, fallen leaves, humus, hay, etc. The most popular way to organize gardening using these materials is hilly «warm» beds.

This type of flowerbed has been used for centuries in Eastern Europe and Germany as part of permaculture and was called Hügelkultur (German – «hilly culture»). In other words, «hilly culture» is a centuries-old traditional way of constructing a flowerbed from rotten logs and plant remains. These mound forms are created by marking an area for a raised bed, clearing the ground, and then applying wood material with compost and earth [5].

The optimal dimensions of a hill-shaped flowerbed are: up to 2 meters wide, from a meter to one and a half in height. The length can be arbitrary. Let's compare how effective it is to organize this type of flowerbeds from the point of view of the rational use of the planted area.

A standard flat bed 2 meters wide and 3 meters long is considered. The planted area will be 6 m². On such a flowerbed, for example, 12-18 bushes of sufficiently large medicinal plants (for example, tansy, Hypericum, oregano, etc.) can fit at the rate of 2-3 plants per 1 m². This area can be used more rationally if a hill-shaped bed of any kind is organized on it, as shown in Figure 1.

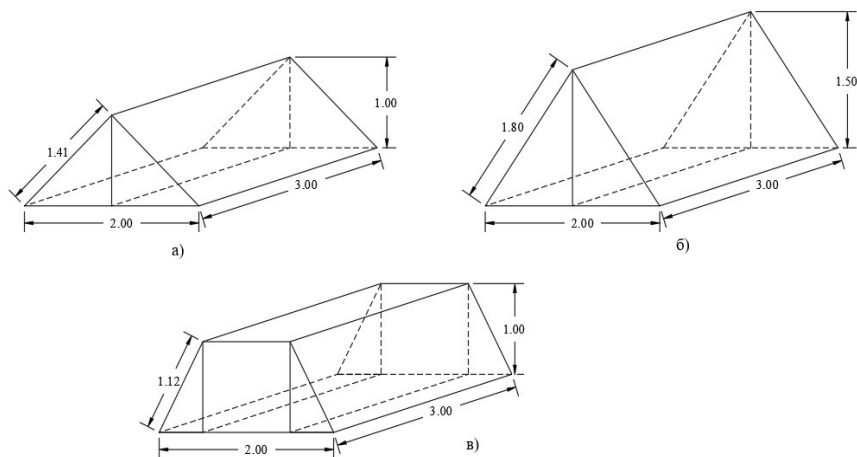


Fig. 1. Examples of hill-shaped beds, m.

For this purpose, it is necessary to dig a shallow pit over the entire area of the flowerbed, preserving the turf or topsoil. The depth of the pit should be from 30 to 50 centimeters, while it is important to maintain the same depth on the entire surface of the bed [5].

This is followed by the hill formation stage. The first layer consists of large logs and fallen trees, followed by a layer of thinner branches, sticks and twigs. A combination of hard and soft woods is recommended. In addition to strength, when choosing wood, it is worth paying attention to the duration of the rotting process and avoiding those types of wood that slowly rot (acacia, cedar, larch). The excavated turf is laid with its roots up on the trees. It can be followed by fallen leaves, mown grass, compost, manure, straw and even cardboard. An important condition is the compaction of the resulting mass and the elimination of voids inside. At the end, the formed pile is covered with a layer of soil about 10 centimeters thick. The completion can be a layer of mulch [5]. The bark of coniferous trees, straw, coniferous needles, fallen foliage, gravel, sphagnum can be used as mulch – the choice of material depends on the crops grown.

It is advisable to build a similar flowerbed in the fall and cover with plastic wrap until spring. During the winter period, the maturation process takes place in it: a layer of leaves and plant residues decomposes, heat is released [6].

Let's calculate what the sown area will be if we organize a hill-shaped flowerbed on a rectangular plot of land 2x3 meters, raising it above ground level by 1 meter. It is clearly depicted in Figure 1 (a). The area of the two side faces will be 8,46 m², it is 1.41 times more than the area of a flat bed occupying the same plot of land.

A similar flowerbed in the form of a triangular prism with a height of 1,5 meters (Fig. 1-b) will have an even larger acreage. Having calculated it, we get a value of 10,8 m², it is almost twice the area of the occupied surface. For example, 21-33 medicinal plants can be placed on such an area, i.e. 2-3 plants per 1 m².

Hill-shaped flowerbeds can be formed not only in the form of a triangular, but also in the form of a straight prism with an isosceles trapezoid in the bases (Fig. 1-c). If the height of such a flowerbed is equal to 1 meter, then the planted area will be 9,72 m². Obviously, the creation of a flowerbed of type (c) is even more expedient than type (a).

Hill-shaped fbds, in fact, create conditions for medicinal plants close to the environment of their natural habitat. The main advantage of this flowerbeds type is that the rotting wood is home to beneficial bacteria, insects, worms and microbes that create nutrients that plants can use [5].

Since decomposition also creates heat, the hill prolongs the growing season. The wood materials forming the core are able to retain and then release rainwater. The installation of hill-shaped beds is a reasonable solution for dry periods, recently often observed in the Urals [1].

Eventually the embankment will descend as the wood rots – to prevent this, a fresh layer of soil or compost is added on top. Thus, it is possible to create a full-fledged ecosystem in which useful organisms will thrive [5].

The second type of vertical gardening, using synthetic materials, can also be described as modular. There are many ideas for creating such a design, but the most popular is a flowerbed made of PVC pipes, which can be arranged horizontally and vertically [4].

The main advantage of creating beds from pipes is the lack of financial investments or their minimal costs, because often after repairs there are underused materials (in this case, pipe trimming) [3].

The optimal method of breeding plants in pipes is hydroponics, i.e. cultivation without the use of soil. However, some designs using large-diameter pipes allow you to organize an entire ecosystem inside, the result of which is a «nutritious tea» for plants. In order to harvest and compost «tea» at the same time, gardeners fill vertically arranged pipes with soil at the edges, and in the very center there is an improvised compost pit with organic residues. At the same time, nutrients formed in the center of such a system penetrate to the roots of plants located along the outer part of the pipe. Watering is carried out from above and it is thanks to this that water seeps through the entire thickness of the soil and organic matter, forming a liquid fertilizer in a special compartment below.

Considering vertically arranged pipes as an example (Fig. 2), it is possible to calculate their planted area.

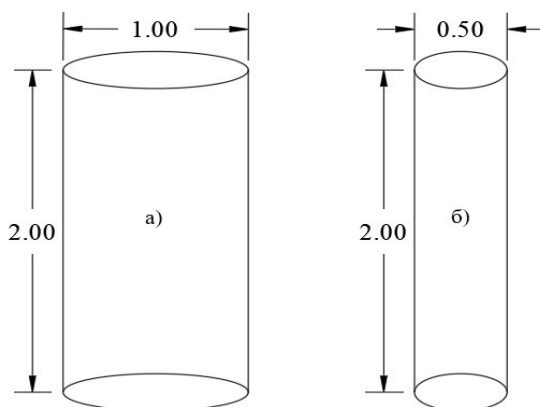


Fig. 2. Examples of vertical pipe beds, m.

This indicator will be equal to 6,28 and 3,14 m² on flower beds of type (a) and (b), accordingly. At the same time, the occupied land area at the flowerbed (a) is 1 m², at the bed (b) – 0,25 m². This means that the surface of the earth on which the vertical beds are placed is used 6,28 times (in the case of (a)) and 12,56 times (in the case of (b)) more efficiently than they were used in traditional crop sowing. Plants with a small root system can be grown in pipes, for example, onions, sage, mint, veronica, etc.

In the process of growing plants by any of the methods described above, problems may arise: an undeveloped root system, drying, and so on. However, in most cases, this is due to the inexperience of the gardener and improper operation of structures. For effective functioning, vertical gardening requires gardeners to have certain knowledge. At the initial

stages, the idea of constructing such flowerbeds may seem laborious and impractical, however, in the future, the results of labor pay off doubly.

4 Conclusion

In conditions of limited use of land resources, vertical gardening acts as an innovative solution to the problem. In symbiosis with hydroponics, vertical flowerbeds are able to eliminate the problem of a shortage of used areas. Hill-shaped beds, having proven themselves in Eastern Europe and Germany, can compete with the traditional «flat» method of sowing used in urban landscapes. With such an organization of gardening, the planted area increases significantly. Despite the fact that vertical gardening is a rather labor-intensive option at the initial stages, nevertheless, the effectiveness of this method justifies the invested material, labor and intellectual resources.

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