

Ecological Significance and Economic Efficiency of Tree Pavlovnia

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Received: 28 January 2026; **Accepted:** 23 February 2026; **Published:** 17 March 2026

Abstract: In this research, the advantages of widespread planting of Paulownia trees in our country, as well as their economic efficiency, growth rate compared to other trees, and the possibility of significantly reducing costs in growing Paulownia were studied and analyzed.

The purpose of the research is to examine the advantages of widespread planting of Paulownia trees, as well as their economic efficiency, the fact that this tree improves atmospheric purity, soil composition, medicinal properties, and the relevance of planting this tree more in the regions to further stabilize the ecosystem of our country. In implementing the tasks planned in the research, the primary data used during the analysis were obtained, analyzed and based on the results obtained by industry experts, and the conclusions presented are scientifically based.

Keywords: Agrotechnical treatment, microelements, macroelements, biomass, plantation, exotic, invitro method, hybrid.

Introduction: The Introduction Within the framework of the nationwide "Yashil makon" (Green Space) project, more than one hundred million Paulownia tree seedlings have been planted across various regions of our country. According to scientists, this tree is highly effective for ecological purposes due to its contributions to atmospheric purification, soil composition improvement, pest control systems, and enhancing the exotic appeal of urban areas.

Relevance of the Topic and Ecological Importance of the Paulownia Tree Although this tree, with a history of nearly five thousand years, is native to China and Japan, it is now cultivated in dozens of countries worldwide. One of the most important characteristics of Paulownia is its ability to supply the atmosphere with large amounts of oxygen. Due to this property, it is recognized as the best air purifier among all broadleaf plants. Its large leaves enable the tree to release substantial quantities of oxygen into the environment. It has been determined that Paulownia produces up to four times more oxygen than an ordinary tree. Ten hectares of Paulownia plantation can absorb

approximately three hundred tons of carbon dioxide. Through this unique feature, it can significantly help purify the increasingly polluted urban air caused by vehicle emissions and industrial enterprises.

In recent times, soil and sand erosion have led to large amounts of dust in the air, exerting a serious negative impact on ecosystems. Naturally mitigating dust or reducing its harm is one of the primary challenges. Paulownia can provide substantial assistance in this regard as well. With its large leaves, Paulownia attracts and neutralizes dust from the air. Ten hectares of Paulownia can neutralize thousands of tons of dust.

Typically, Paulownia can grow and adapt even in infertile soil conditions. It does not require soil rich in various minerals. It adapts well to sandy and dry soils while actively contributing to preventing soil desertification. Once firmly established in the soil, it can withstand drought effectively starting from the second or third year. It develops best in moderately moist, temperate, sandy-gravelly soils. In waterlogged areas, the tree is susceptible to infections and has a higher risk of dying.

Drought and Heat Resistance During the first two years, it requires regular watering—30–40 liters per seedling, with irrigation no more than twice a week. After the root system develops, starting from the third year, special irrigation is no longer necessary.

Paulownia helps prevent soil erosion. Its roots penetrate deeply into the soil, preventing it from sliding away. Therefore, it is recommended to plant it on slopes.

Due to its rapid growth, Paulownia roots absorb significant amounts of heavy metals from the soil, thereby purifying it. For this reason, it is called the tree of the 21st century.

Some trees have slightly unpleasant effects on humans. For this reason, trees of certain species are not recommended for planting in residential areas, particularly in home courtyards. However, Paulownia does not belong to such species. It can be freely planted in courtyards and open spaces in front of homes. Considering one of its beneficial properties, some people prefer planting it specifically in residential areas.

Paulownia continuously accumulates tannin substances in its body. Since these substances are sufficiently toxic, they protect the tree from termites, beetles, flies, and various insects. In some countries, Paulownia seedlings are planted around homes to protect against insects in hot weather. Pests cannot approach areas where this tree is present. In this way, the tree protects not only itself but also the surrounding ecosystem, including humans, from pests.

The tree's property of not absorbing excessive moisture ensures resistance to several diseases common in plants and trees. It is not particularly sensitive to fungal infections, which are more common in rainy and waterlogged soils.

Experts also suggest that it can serve as a barrier to noise. However, this property is more pronounced in Paulownia wood rather than the tree itself.

The tree's low moisture absorption results in wood that is dense yet very light. One cubic meter can weigh up to 250 kilograms.

Another important feature of Paulownia is its distinctive decorative appearance. It is mainly planted around homes, gardens, avenues, promenades, and cities to enhance environmental beauty. The tree's appearance captivates people in several ways and evokes admiration.

First, the tree's wood has a unique beauty unlike that of other trees. Its smooth, grayish trunk and branches amaze people. The trunk circumference of a 1.5–2-year-old tree is 8–14 cm, that of a 3–4-year-old tree is

20–24 cm, and that of a mature tree exceeds 80 cm. Its height can reach up to 25 meters. Annual height growth reaches up to 1.5 meters, and by age 10, Paulownia can reach 15 meters, making it one of the fastest-growing trees in the world. Overall, it lives for more than a hundred years.

Its leaves, resembling elephant ears, stand out due to their size. Leaf diameter reaches 50–85 cm. The leaf shape is sometimes heart-shaped or oval, with rounded edges. The color is light green; the upper surface is smooth, while the underside is slightly fuzzy. The leaf color remains unchanged until late autumn. Even when falling, they retain their green color initially before turning brown.

The tree first flowers at 4–5 years of age. The flowering period, occurring in late spring, lasts 6–8 weeks. When in bloom, it turns pure white like a bride. Sometimes it can bloom in purple hues. Occasionally, Paulownia may bloom again in August with a lush green crown.

Its fruits are capsules containing numerous small winged seeds. Though tiny, they add a special charm to the tree. Especially during flowering, the tree emits a pleasant fragrance, attracting bees. Honey produced from its nectar also has the same pleasant aroma.

Paulownia has a significant impact on urban exoticism. Areas with large numbers of these trees are very suitable for people to relax and unwind. Therefore, planting more Paulownia in sanatoriums, avenues, and recreation parks is beneficial for the ecosystem in every way.

When people think of tree wood, construction material often comes to mind first. However, Paulownia wood is a valuable raw material for several other purposes.

Due to its very light yet strong nature, it is highly useful for making essential ship parts. Its beautiful silvery-brown color is used in producing various luxury items, household goods, and souvenirs. Its excellent acoustic properties and very low moisture content make it suitable for manufacturing musical instruments and sports equipment. It is also used in industry for producing high-quality newsprint.

It is often used as biofuel and for wood chips in forestry. Paulownia leaves are suitable for fodder production, as their quality and protein content (20%) are close to alfalfa, and they are inexpensive. The leaves contain a lot of protein, serving as excellent feed for livestock. The tree's leaves, flowers, and fruits have been used in folk medicine for centuries. Currently, they are important raw materials for the cosmetics and pharmaceutical industries. Paulownia is considered the world's fastest-growing ornamental tree with high-quality wood suitable for construction.

Paulownia wood dries quickly and is lightweight. For comparison, one cubic meter of oak wood averages 850 kg, pine 482 kg, while Paulownia reaches a maximum of 282 kg.

Technical Characteristics of the Wood Analyses of Paulownia wood structure show many air pockets, providing insulation from heat and cold, and low sound conductivity—no other tree matches Paulownia in this regard. Additionally, its properties remain unchanged in water and humidity, making it highly valued for saunas and parquet flooring. Paulownia wood has an average density of 210–300 kg/m³, is soft, and flexible. Currently, on the world market, one cubic meter of Paulownia wood is priced at \$200–\$400, depending on the tree's age at cutting, diameter, and processing level. With proper agro-technical care, 350–500 m³ of high-quality wood can be obtained from one hectare in 7 years. In Uzbekistan's conditions, considering 6–7 meters of growth in the first year, more than 500 m³ of wood can be obtained from one hectare after 7 years.

Paulownia tree leaves and young stems are used for feeding livestock and fish, with nutritional value very close to alfalfa. Paulownia leaves contain 20% protein; in fallen and dried autumn leaves, it is 12%. They are rich in microelements, with digestibility at 60%. Young one-year-old shoots have even higher protein content, making them valuable for biomass production for specific livestock. From one hectare, 30–40 tons of high-quality biomass can be obtained during summer months. Annual regrowth with minimal agro-technical care makes this feed very cost-effective.

Paulownia leaves contain substances highly beneficial for the liver, gallbladder, and lungs. In China, the beneficial properties of Paulownia have been well known since ancient times; today, many medicines are produced from it in the pharmaceutical industry. Its leaves have other properties as well and are used in cosmetics in some Asian countries.

Paulownia awakens from winter dormancy in March–April. It produces bell-shaped flowers 6 cm long and 10–15 cm inflorescences. Flower colors are light pink mixed with light purple; some varieties are almost white, emitting a vanilla-like fragrance. In the perfume industry, unique-scented perfumes are made from Paulownia.

Paulownia grows quickly and beautifully, flowering profusely for a long time and producing large amounts of nectar. Bees fly from afar to collect nectar from its sweet-scented flowers. From one hectare of Paulownia plantation, 250–300 kg of honey can be harvested. Paulownia honey is light, transparent, bright in color, and wonderfully aromatic, comparable in quality to acacia honey. This honey is medicinal, serving as a

remedy for bronchitis, lung, and respiratory diseases; it improves gallbladder function, liver activity, and digestion. The benefits of Paulownia honey stem from the abundance of biologically active substances in its flowers.

Using Paulownia as fuel has many advantages: first, its rapid growth yields large biomass; second, burning produces very few toxic emissions. Besides industrial use, it is burned as pellets in automated boilers and home stoves. Currently, it is widely planted as raw material for bioethanol production. American scientists have achieved 511 liters of bioethanol from one ton of dry Paulownia wood using thermochemical and biotechnological methods. This alone has earned it the nickname "oil well." Establishing innovative technology-based plantations of fast-growing trees, including Paulownia, is one of the ecological solutions for saving energy resources and protecting the environment. To develop handicrafts, construction materials, wood and wood-chip raw material production, meet furniture industry needs, sharply reduce imports, and satisfy the population's alternative energy needs, the Cabinet of Ministers of the Republic of Uzbekistan adopted Resolution No. 520 dated August 27, 2020, on measures to establish plantations of fast-growing industrial Paulownia trees.

ECONOMIC ANALYSIS RESULTS

A brief business plan calculation for planting and profiting from Paulownia on one hectare: With a 4×4 m scheme, 625 seedlings fit per hectare. With proper care under a 4×4 scheme, 1–2 m³ of wood material can be obtained per tree in 6–8 years. Assuming an average of 1 m³ per tree sold at a minimum of \$250 per m³, revenue would be 625 × \$250 = \$156,250. Additionally, intercropping, beekeeping, and selling branches after harvesting can provide extra income.

If planted in a 2×2 m scheme, revenue can more than double. For example, 2,500 seedlings fit per hectare. With proper agro-technics, half can be thinned and sold after 3–4 years, the rest after 6–8 years. The first 1,250 trees yielding 0.25 m³ each produce 312.5 m³; at \$200 wholesale, this yields \$62,500. The remaining 1,250 trees yielding 1 m³ each produce 1,250 m³; at \$250, this yields \$312,500. Total: \$62,500 + \$312,500 = \$375,000, plus additional income from intercropping, beekeeping, and branch sales.

Paulownia can be planted as the main crop in open-field plantations, intercropped with soy, wheat, cotton, corn, etc., along roads, railways, around cafes, shops, and new buildings at 4–5 m distance.

Paulownia Does Not Select Soil and Methods of Growing Seedlings Paulownia is not picky about soil; it can grow even in soils with 2% alkalinity or low salinity,

but it develops best and fastest in moist, fertile soils. It dislikes extreme drought or excessive moisture.

Key considerations for establishing Paulownia plantations:

1. Not recommended for rain-fed (non-irrigated) lands; planting possible only with irrigation.
2. Not recommended where groundwater is higher than 1.5–2.0 m, as roots reach water quickly, leading to rot and halted development. Nurseries can be established where groundwater is at 1.5 m.
3. On rocky soils, areas with poor moisture retention, or high salinity, dig 2 m deep pits, fill with compost, ensure moisture retention, then plant.

Methods of Growing Paulownia Seedlings Paulownia seedlings are mainly grown in three ways:

1. From seeds: This is somewhat complex; seedlings may vary in size during germination. The advantage is higher survival and adaptation when transplanted to open ground.
2. From root cuttings or root suckers: Seedlings are stronger than seed-grown ones; one-year-old root-cuttings develop quickly in plantations. Trunk diameter difference from top to bottom is minimal (like spruce or pine), allowing more wood volume per tree.
3. In vitro method: In a lab, one selected seedling is divided to propagate. Advantage: uniform growth. Drawback: long process and lower survival rate when transplanted to open ground due to difficult adaptation; some may die.

CONCLUSION

In our country, widespread introduction of Paulownia planting offers advantages including economic efficiency, faster growth compared to other trees, and significantly reduced cultivation costs. Alongside these, its benefits in improving atmospheric purity, soil composition, medicinal properties, stabilizing the ecosystem, and the urgency of planting more in regions are evident. Large-scale planting can noticeably improve air quality, enabling international ecological certification and earning carbon credits (carbon quotas) subsidies or payments under the green economy.

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