

"PAULOWNIA SPECIES" GROWING FOR SAPLINGS IN POTS IN ROMANIA: TECHNOLOGICAL ASPECTS AND COMPARATIVE EXPENSES, INCOMES AND PROFIT

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Abstract

The paper aimed to comparatively analyze the economic efficiency of Paulownia Species, Shan Tung variety, grown for producing 10,000 saplings in pots at SC Galya 3000 SRL, Cerneteaz Commune, Timis County, Romania in the year 2016. The research includes three alternatives for producing 10,000 saplings in pots as follows: V1- saplings in pots 7x7x8 cm, V2- saplings in pots of 19 cm, and V3-saplings in pots of 36 cm. In case of V3, the production cost for 8 months to produce saplings of 1-1.5 m height in a pot of 36 cm was Lei 8.95, 2 times higher compared to V2, where the cost per sapling of 50 cm in a pot of 19 cm was Lei 4.06 and 7.16 times higher than in case of V1, where the cost per sapling of 4 cm in a small pot of 8 cm was Lei 1.25. The income is 6 times higher in case of V3 compared to V1 and 2 times higher compared to V2, and as a consequence, the gross profit increases from V1 to V3, while the profit rate decreases from 300.14 % in case of V1 to 235.04 % in case of V3. Therefore, the profit rate is enough high to consider Paulownia growing a real business for all the three variants. As a final conclusion, Paulownia tree growing is a real business for farmers interested to get income and profit in a short period of time varying from 1.5 months to 8 months. Also, the plants could be grown in plantations for fuel and furniture wood whose price is much higher if the wood is sold in the international market.

Key words: economic efficiency, growing, Paulownia Species, Shan Tung variety, saplings in pots

INTRODUCTION

Paulownia Sp. has its origin in China, where about 2,600 years ago it was used for timber. At present, the plant is largely spread in China, Vietnam, Laos, Japan, Korea, in general in Asia, but also it is cultivated in Australia and America.

The name of *Paulownia* was given in honour of Anna Paulowna, Queen consort of the Netherlands (1795–1865), daughter of Tsar Paul I of Russia. For this reason, the plant it is named "princess tree".

From a botanical point of view, it belongs to the "*Pauloniaceae family*", consisting of a large number of species. At present, there are many *Paulownia* species, among the most important being: *P. tomentosa*, *P. fortunei*, *P. elongata*, *P. albiphloea*, *P. catalpifolia*, *P. australis*, *P. kawakamii*, *P. taiwaniana*, *P.*

fargesii, *P. glabrata* [8].

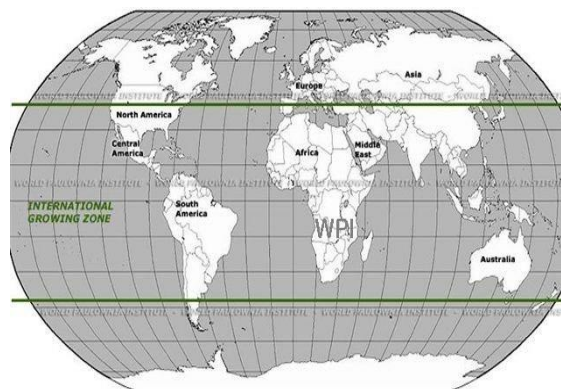


Fig.1. World zones where *Paulownia* is grown
Source: <http://www.worldpaulownia.com/international-map/> [14]

The species are able to adapt easily to different climate and soil conditions. But the plant has better results when it is cultivated

on fertile soils, deep loose sandy soils. The only condition is as the water table to be deeper than 1.5 m. Also, the optimum temperatures for *Paulownia* growing are ranging between - 20 and + 45 Celsius degrees. However, the plant requires a lot of water to grow well and mainly in the warm seasons, because the tree has a high transpiration rate.

It is a fast growing tree, at the age of 6-7 years reaching about 15 meters height and the age of 10 years it has about 30-40 diameter and 0.3-0.5 m³ volume of timber. The timber is strong and dries easily, its grain is fine and it is resistant to deformation, cracking or wrapping.

For this reason, the *Paulownia* tree has a large range of uses, being cultivated for the following purposes: (i) fuel wood, (ii) furniture of high quality, plywood and musical instruments (guitars etc), wood for planes and ships, because the wood can be easily carved, (iii) for intercropping in agriculture, as it is able to develop a suitable climate for agricultural crops increasing yields, (iv) an organic fertilizer because the leaves are rich in Nitrogen, (v) the leaves can be also used as animal fodder, (vi) fuel pellets for heating, (vii) the flowers are rich in nectar completing the picking alternatives for bee families and contributing to an increased honey production, (viii) for landscape architecture in the urban and rural areas, (ix) for protecting roads, farms, houses etc, against wind and snow storms, (x) for reclamation of the areas affected by mining, (xi) for the afforestation of various areas where forests were cut or are insufficient, (xii) the flowers and leaves have medicinal properties. [11, 15]

The *Paulownia* leaves contain: protein 22.6 %, Organic matter 91.4 %, Phosphorus 0.6 %, Calcium 2.1 %, Iron 0.6 %, Zinc 0.9 %, 7.8 % ash, metabolizable energy 15-18 MJ/kg. [3]

The *Paulownia* wood is surnamed "the wood aluminum". About 2 thirds of a tree could be used for timber, and one third for biomass for producing green energy. The price of one cubic meter of timber is about Euro 500. [9]

Paulownia can be multiplied from seeds, roots or stem cuttings. In order to produce genetically uniform clones of high quality for

agro-forestry, micropropagation techniques are largely applied by various researchers [1, 5].

Another important method for *Paulownia* propagation is seedlings production.

The seeds are very small. In one gram of seeds there are 2,666-3,333 seeds, or 1,000 seeds weigh 0.17-0.25 g depending on variety. The seeds germination rate also depends on hybrid and ranges between 70 % up to 90 %.

In Romania, the researches on *Paulownia Sp.* started since 1984-1986 for finding possibilities to produce wood with special uses and reduce wood import. [10]

In the last decade, *Paulownia Sp.* was cultivated on various surfaces in different regions of Romania. At present, *Paulownia* growing for saplings and wood has become a real business.

Paulownia tree has a special chemical composition and a high energetic value, a reason to be suitable to produce bioethanol in Romania. [7]

In Romania, the Shan Tong hybrid, which is a selected clone resulted from the combination of two species: *P. tomentosa* x *P. fortunei*, has started to be recently cultivated. Its main qualities are: the well developed saplings of one year old which can be easily planted directly in the field and the high quality of timber plantations, as the tree lignifies faster.

In Romania, other researches on *Paulownia* trees were done in nurseries created in greenhouses and in the field at ICAS Ștefănești, Simeria and Hemeiuș, Transilvania, [2] and the behaviour of the plantation of *Paulownia tomentosa* created based on pot seedlings was also studied. [4]

În 2014 there were created *Paulownia* plantations over 100 hectares in 10 counties of Romania (Timiș, Constanța, Galați, Teleorman, Călărași, Sălaj, Cluj, Satu Mare, Sibiu, Suceava, and Bihor. [6]

In Romania, the cities Baia Mare, Cluj-Napoca, Băile Herculane, Timisoara, Arad, București, Buzău, Horezu-Mănăstire, Govora Băi, Caracal, Craiova, Miniș, Slatina, Tîrgu Jiu, Vaslui have old *Paulownia trees* whose age varies between 30-50 years. [13]

In this context, the objective of the paper was to present three business alternatives of

Paulownia production as saplings in pots and the related costs, income, profit and profit rate to prove that this tree could be a big deal for the Romanian farmers.

MATERIALS AND METHODS

The experiments were carried out at the firm SC Galya 3000 SRL [12], situated in Cerneteaz Commune, Timis County, in the West part of Romania. The period of experiments lasted 8 months from February till September 2016.

The *Paulownia* hybrid used in this experiment was Shan Tung variety, imported as phytosanitary certified seeds from China.

A number of 10,000 saplings were considered the goal of the experiment.

The project designed in this research includes three alternatives for producing 10,000 saplings in pots as follows: V1- saplings in pots 7x7x8 cm, V2- saplings in pots of 19 cm, and V3-saplings in pots of 36 cm.

For each experimental variant, it was presented the production technology and the related costs, income, profit and profit rate.

The results for the three variants were comparatively analyzed regarding this indicators.

RESULTS AND DISCUSSIONS

The calendar for producing *Paulownia* plants was the following one: *February* was the month when the experiments started. The small seeds were put into cell trays in a special room where the temperature was about 27-28 Celsius degrees. After germination, in maximum 10 days from sowing, the small plants have appeared. The germination rate was 75 %, therefore 25 % seeds were lost. In *March*, at the age of 1-1.5 months, the plants reached about 4 cm height, when they were transferred from the cell trays into small pots of 7x7x8 cm. About 16.66 % losses were recorded after the plant transfer in small pots. In *April*, the plants continued to grow and in *May*, they reached 10 cm height. From this moment, there are two alternatives to use the small plants: (a) to move the plants of 10 cm height and 1-1.5 cm diameter in a *Paulownia*

nursery, and (b) to transfer the plants from the small pots 7x7x8 cm into pots of 19 cm. In our experiments, the small plants were moved into pots of 19 cm. In *June and July*, the plants growth continued so that in *August*, they reached 50 cm height. In *September*, the plants could be used in four directions: (i) to be moved from the post of 19 cm into post of 36 cm and continue their growing or to be sold as such on the market, (ii) to be moved in larger pots of 50 cm when they have 60 cm height; (iii) to be planted directly in the field in pits of 0.8-1 m depth; (iv) to remain to be grown in pots of 19 cm till December. In this experiment, the plants were transferred from small pots of 19 cm into pots of 36 cm in order to be sold as such in the market.

V1-Producing 10,000 saplings in small pots 7x7x8 cm.

Seeds. The average number of seeds used in this variant was 3,000/g. For producing 10,000 saplings in small pots, it was needed 16,000 seeds imported from China, as phytosanitary certified seeds. It was needed to take into account that the sprouting rate is 75 % and at the transfer of the plants from cell trays into pots of 7x7x8 cm, there are 16.66 % plant losses. Therefore, 5.4 g of seeds were bought at the price of USD 2.66/g (all taxes included). The cost of seeds acquisition totalized USD 14.36, or, at an exchange rate 1 USD= Lei 3.95, this meant Lei 56.72.

Cell trays. The seeds are put into special cell trays. In this experiment there were used the trays with 104 cells, whose price is Lei 1.7/tray. Therefore, for sowing 16,000 seeds, there were needed 154 trays, whose total cost was Lei 261.8.

Sprouting substratum is represented by TS 3 peat, which has a fine granulation (0-7 mm) and pH= 5-5.5. This sort of peat is imported from Lithuania. To fill the 104 cells of a tray, it is needed 500 g peat, therefore for all the 154 trays it was needed the amount of 77 kg peat. Peat is commercialized in sacks of 200 liters (equivalent to about 50 kg peat) and the price is Lei 63/sack. Therefore, two sacks of peat are enough and their cost is Lei 126.

After sowing, the small plants of 1 cm height will appear in 10 days and they will continue their growth till they reach 3-4 cm height at

the age of 1-1.5 months.



Photo 1. *Paulownia* seedlings in a cell tray.

Source: Original photo.

Watering is compulsory to help the sprouting process and plants to grow. For 50 plants, its i needed 2 liters water/one watering and 3 waterings are enough per week at this stage of vegetation. To water 16,000 seeds and seedlings it is required an amount of 1,920 liters (1.92 m³) water, which is supplied at the price Lei 4.50/ m³. Therefore, water cost is Lei 8.64.

The water needs to be assured by a Submersible Pump QDX 1.4 32 M, 1.4 KW engine power and 5,000 liters/hour (5 m³) water flow. The pump price is Lei 239. For pumping 1,920 liters water, it is consumed 0.53 KW and taking into account the price of electricity Lei 0.2734/KWh, this means Lei 0.15 expenses.

Biostimulation for germination and growth. At the same time with the water assurance, it is needed to apply Atonik biostimulator (1 ml/1 liter water), more exactly 2 liters for the whole amount of water 1,920 liters. The price of biostimulator is Lei 165.7/liter, therefore, the two liters cost was Lei 331.4.

Heating in spring season. When it is cold outdoors, like in February and March, in the room where the plants are grown in cell trays, it is needed to assure 27-28 Celsius degrees for germination and plant growth. In this purpose, an electric heater of 2,000 W, with a consumption of 48 KW/day is needed for a

period of about 45 days when the plants are in this stage of vegetation. For the whole period, the electricity consumed by heater totalize 2,160 KWh, and at the price Lei 0.2734/KWh, this means Lei 590.50 total cost with heater electricity consumption.

Labor force required to fill the 154 trays with peat, to sow the seeds and wet the plants is represented by one permanent employee for the duration of 45 days and one worker working only 7 days for filling the cell trays with peat and 2 days for sowing the seeds. At a tariff of 100 lei/working day, the total labor cost accounted for Lei 5,400.

Transfer of 12,000 small plants from cell trays into small pots 7x7x8 cm. Taking into account that the germination rate is 75 %, therefore 4,000 plants were lost (925%), only a number of 12,000 plants will be moved into small pots.

(a) *The acquisition of the 12,000 small pots 7x7x8 cm* at the price Lei 0.08/pot, lead to Lei 960 total cost.

(b) *The substratum in small pots*, was represented by 14 sacks of TS 3 peat, bought at the price Lei 63/sack of 200 liters. Therefore, the total cost with peat substratum in small pots is Lei 882.

(c) *Watering the plants in small pots* needed 7,200 liters water, whose cost was Lei 32.4, considering that a plant in a pot must receive 150 ml water two times a week for a period of two weeks.

(d) *The Atonik biostimulator* was also used to help plant growth in small pots, in the same concentration ratio (1 ml biostimulator/1 liter water). For the amount of 7,200 liters of water required to wet the plants, the related cost with Atonik biostimulator accounted for Lei 1,205.7.

(e) *The submersible pump* has to operate 3.6 hours to assure the needed water volume, and this means 5.04 KWh and electricity cost is Lei 1.38.

(f) *The labor force* required to transfer the small plants from cell trays into small pots 7x7x8 cm is represented by 4 workers who must work 6 days for a tariff of Lei 100/working day, totalizing Lei 2,400 labour cost. The number of working days was established taking into account that a worker

is able to transfer only 500 plants/working day from cell trays into small pots.

The expenses related to the production technology for producing 10,000 *Paulownia* saplings in pots 7x7x8 cm are presented in Table 1.

Table 1. The expenses related to the production technology for producing 10,000 *Paulownia* saplings in pots 7x7x8 cm

Crt. No.	Cost item	Total Expenses (Lei)
	MATERIALS	
1	Seeds	56.72
2	Cell trays	261.80
3	Small pots 7x7x8 cm	960.00
3	Peat substratum, of which: -for sprouting in cell trays -in small pots 7x7x8 cm	1,008.00 126.00 882.00
4	Watering, of which: -seeds and plants in cell trays -plants in small pots 7x7x8 cm	41.04 8.64 32.40
5	Submersible pump 1.4 KW, 5 m ³ /h	239.00
6	Atonik biostimulator, of which: - for seeds and plants in cell trays -for plants in small pots 7x7x8 cm	1,537.10 331.40 1,205.70
7	TOTAL MATERIALS	4,103.66
8	SERVICES WITH THIRDS	
9	Electricity, of which: -for pumping water for seeds and plants in cell trays -for heating in spring season -for pumping water for plants in small pots 7x7x8	592.03 0.15 590.50 1.38
10	TOTAL SERVICES WITH THIRDS	592.03
11	LABOR	
12	Labor force, of which: -for working with seeds and plants in cell trays -for working with plants in small post 7x7x8 cm	7,800 5,400 2,400
13	TOTAL LABOR	7,800
14	TOTAL PRODUCTION EXPENSES	12,495.69

Source: Own calculation

Therefore, for producing 10,000 saplings in small pots of 7x7x8 cm, the production costs are Lei 12,495.69, of which the expenses with the required materials represent 32.84 %, the labor costs represent 62.42 % and the cost with the thirds for electricity delivery represent 4.74 %.

V2-Producing 10,000 saplings in pots of 19 cm diameter

Seeds. In this case, it is needs to start with 16,900 seeds, which at a germination rate of 75 % will led to 12,675 small plants in cell trays. After the transfer from cell trays into

small pots of 7x7x8 cm, 2,112 plants (16.66%) will be lost. Taking into account that after the transfer from small pots 7x7x8 cm into pots of 19 cm, the loss of plants is small, more exactly 5.34 % (563 plants), finally, 10,000 saplings at a height of 50 cm in pots of 19 cm could be sold in the market.

Therefore, the 16,900 seeds means 5.63 g seeds, which are bought at the price USD 2.66/g. This means USD 14.98 or, at the exchange rate of 1 USD=Lei 3.95, this means Lei 59.17, total cost with the seeds acquisition.

Cell trays. For 16,900 seeds it is needed 163 trays (a tray with 104 cells), which are bought at the price Lei 1.7 lei/tray. Therefore, the acquisition of all the trays totalizes Lei 277.1.

Substratum for germination and plant growth. In this purpose, it is used TS 3 peat (0-7 mm granulation), ph= 5-5.5, imported from Lithuania. The amount of peat to fill the cells of a tray with 104 cells is 500 g peat. Therefore, for 163 trays it is needed 81.5 kg peat. Because, it is known that a sack of peat has 200 liters (50 kg), it is needed to buy 2 sacks and at the price Lei 63/sack, the total cost with peat acquisition is Lei 126.

Watering. It is known that for 50 plants in this stage it is needed 2 liters water/watering and 3 times a week, totalizing 6 liters. For 16,900 seeds and plants, it is needed 2,028 liters water, at the price Lei 4.50 m³, this means Lei 9.14 watering cost.

Submersible pump QDX 1.4 32 m, 5 m³/h water flow costs Lei 239.

Electricity for water pumping. Taking into account that the pump has 1.4 KW power and gives 5,000 liters/hour, it is needed 2,028 liters water to be pumped, and this means 0.57 KWh electricity consumption. At the tariff Lei 0.2734/KWh, this means Lei 0.16 cost with electricity.

Biostimulation for germination and growth. For V2, it is needed to apply Atonik biostimulator (1 ml/1 liter water), more exactly 2 liters for the whole amount of water 2,028 liters. The price of biostimulator is Lei 165.7/liter, therefore, the two liters cost was Lei 331.4.

Heating in spring season. Taking into

account that, the electric heater of 2,000 W will operate daily in February, March and April, that is 89 days, this means 4,272 KW consumed and at the tariff Lei 0.2734/KWh, this means Lei 1,168, heating cost.

Labor force. For filling the 163 trays with peat and taking care of plants from February to May, that is 89 days, it is needed one permanent employee and one worker to fill the 163 trays with 81.5 kg peat in 2.5 days and to put 2,500 seeds/day in trays, he needs about 7 working days. At the tariff Lei 100/day, the total labor cost accounts for Lei 9,850.

Transfer of 12,675 small plants from cell trays into small pots 7x7x8 cm.

(a)*The acquisition of the 12,675 small pots 7x7x8 cm* at the price Lei 0.08/pot, lead to Lei 1,014 total cost.

(b)*The substratum in small pots*, was represented by 14 sacks of TS 3 peat, bought at the price Lei 63/sack of 200 liters. Therefore, the total cost with peat substratum in small pots is Lei 882.

(c)*Watering the plants in small pots.* Knowing that a plant receives 150 ml water 2 times a week, and the duration of watering is 8 weeks from the middle of March to the middle of May, this lead to 2.4 liters/plant in pot and multiplied by 12,675 pots (plants), it totalizes 30,420 liters water, i.e. 30.42 m³, and the tariff Lei 4.5/ m³, it results Lei 136.89 watering cost.

(d)*The Atonik biostimulator* for plants in small pots is used to help plant growth, in the same concentration ratio (1 ml biostimulator/1 liter water). For the amount of 30,420 liters of water required to wet the plants, the related cost with Atonik biostimulator accounted for Lei 5,059.30, because there were bought 30 liters at the price Lei 165.70 /liter and 500 ml Atonik at the price Lei 88.30/dose of 500 ml.

(e)*The electricity consumption made by the submersible pump.* Knowing that the pump of 1.4 KW provides 5,000 liters/hour, for 12,675 plants and for a period of 8 weeks, it is needed the amount of 30,420 liters water. In this purpose, the pump must operate 6.084 hours, consuming 8.52 KWh and at the tariff Lei 02.734/KWh, the total cost with electricity for pumping is Lei 2.33.

(f)*The labor force* required to transfer the small plants from cell trays into small pots 7x7x8 cm is

represented by 4 workers who are able to transfer 500 plants/working day, this means about 6.5 working days and at the tariff Lei 100/day, the total labor cost is Lei 2,600.

Transfer of the plants of 10 cm height from small post 7x7x8 cm into pots of 19 cm

(a)*The acquisition of the 12,675 pots of 19 cm* at the price Lei 1.01/pot, lead to Lei 12,801.75 total cost.

(b)*The substratum for plants in pots of 19 cm* is a mixture consisting of manure, sand, perlite, peat with big granulation and garden ground. For the 12,675 pots, there were required the following amounts of these components of the mixture: 2,281.50 kg manure, 1,267.5 kg sand, 126.75 liters perlite, 633.75 kg peat and 633.75 kg garden ground. As a consequence, there were bought:

(i) 156.1 sacks manure at the price Lei 10/sack, meaning Lei 1,521 manure cost;

(ii) 0.75 m³ sand at the price Lei 40/ m³ sand, meaning Lei 30;

(iii) 2 sacks of perlite at the price Lei 85/a sack of 100 liters, meaning Lei 170;

(iv) 51 sacks of peat at the price Lei 20.24/ an Agro CS sack of 50 liters, meaning Lei 1,032.24;

(v) 13 sacks of garden ground of 50 kg each at the price Lei 23/sack, meaning Lei 299. Therefore, the total expenses with the substratum mixture needed to fill the 12,675 pots of 19 cm account for Lei 3,052.24.

(c)*Labor for transferring the plants from small pots 7x7x8 cm into pots of 19 cm.* Because 2,000 plants/working day could be transferred by 4 workers, there are needed 6.5 working days and the tariff per day is Lei 100/person. In this case, the labor cost for this operation account for Lei 2,600.

(d)*Watering the plants in pots of 19 cm.* In this purpose, it is needed a Kärcher sprinkler with a complete rotation, PS 300, 703 m², with a sprinkling ray 30 m, and water flow 18 liters/min (1,080 liter/hour). The sprinkler price is Lei 66.59/piece. Arranging the pots in a squared shape, 113 pots of 19 cm on the side of the square and 114 pots on the other side, the surface covered by the 12,675 pots of 19

cm totalize 465 m². In this case, the sprinkler is placed in the middle of the square with pots.

Table 2. The expenses related to the production technology for producing 10,000 *Paulownia* saplings in pots of 19 cm

Crt. No.	Cost item	Total Expenses (Lei)
	MATERIALS	
1	Seeds	59.17
2	Cell trays	277.1
3	Small pots 7x7x8 cm	1,014
4	Pots of 19 cm	12,801.75
5	Peat substratum, of which: -for sprouting in cell trays -in small pots 7x7x8 cm	1,008.00 126.00 882.00
6	Substratum mixture for plants in pots of 19 cm, of which: -manure -sand -peat -perlite -garden ground	3,052.24 1,521 30 1,032.24 170 299
7	Watering, of which: -seeds and plants in cell trays -plants in small pots 7x7x8 cm -plants in pots of 19 cm	437.63 9.14 136.89 291.60
8	Submersible pump 1.4 KW, 5 m ³ /h	239.00
9	Sprinkler PS 300, 703 m ² , 30 m sprinkling ray, 18 liters/min water flow	66.59
10	Atonik biostimulator, of which: - for seeds and plants in cell trays -for plants in small pots 7x7x8 cm	5,390.70 331.40 5,059.30
11	TOTAL MATERIALS	24,346.18
12	SERVICES WITH THIRDS	
13	Electricity, of which: -for pumping water for seeds and plants in cell trays -for heating in spring season -for pumping water for plants in small pots 7x7x8 cm -for pumping water for the plants in post of 19 cm	1,175.46 0.16 1,168.00 2.33 4.97
14	TOTAL SERVICES WITH THIRDS	1,175.46
15	LABOR	
16	Labor force, of which: -for working with seeds and plants in cell trays -for working with plants in small post 7x7x8 cm -for working with plants in pots of 19 cm	15,050 9,850 2,600 2,600
17	TOTAL LABOR	15,050
18	TOTAL PRODUCTION EXPENSES	40,571.64

Source: Own calculation

The water amount used to wet the 12,675 post of 19 cm was calculated taking into consideration that the sprinkler water flow 1,080 liters/hours, the need to wet the plants for two hours and three times a week for a

period of 10 weeks. This totalize 64,800 liters or 64.8 m³ and at the tariff Lei 4.5/ m³, it results Lei 291.6 water cost.

The 64,800 liters water are pumped by the pump of 1.4 KW and 5,000 liters/hour water flow, meaning that there are required 13 hours. In this case, the electricity consumption is 18.2 KWh and at the tariff Lei 0.2734/KWh, it results Lei 4.97 electricity cost for pumping.

Therefore, the total expenses with watering the pots of 19 cm account for Lei 363.16.

As mentioned at the beginning of the V2 presentation, during the growth of plants in post of 19 cm, it is recorded a loss of 5.34 % plants, that is 563, finally, remaining 10,000 saplings at a height of 50 cm in pots of 19 cm to be sold in the market

The expenses related to the production technology for producing 10,000 *Paulownia* saplings in pots of 19 cm are presented in Table 2.

Therefore, for producing 10,000 saplings in small pots of 19 cm, the production costs are Lei 40,571.64, of which the expenses with the materials represent 60.00 %, the labor costs represent 37.09 % and the cost with the thirds for electricity delivery represent 2.01 %.

V3-Producing 10,000 saplings in pots of 36 cm diameter. All the technological and economical aspects of V2 are available for V3 till the moment of saplings transfer from the pots of 19 cm into the pots of 36 cm diameter. The plants of 50 cm height at the age of 4 months in the month of May are transferred from the pots of 19 cm into pots of 36 cm, where they are grown till they attains 1-1.5 m height at the age of 8 months, that is at the end of August, and the beginning of September.

(a) *The acquisition of the 10,000 pots of 36 cm at the price Lei 3.3/pot, means Lei 33,000 total cost.*

(b) *The substratum for plants in pots of 36 cm is represented by the same mixture consisting of manure, sand, perlite, peat with big granulation and garden ground used in case of V2.*

For the 10.000 pots of 36 cm, there are required the following amounts of these components of the mixture: 2,700 kg manure,

1,500 kg sand, 150 liters perlite, 750 kg peat and 750 kg garden ground. As a consequence, there bought:

(i) 180 sacks manure at the price Lei 10/sack, meaning Lei 1,800 manure cost;

(ii) 0.89 m³ sand at the price Lei 40/ m³ sand, meaning Lei 35.6;

(iii) 2 sacks of perlite at the price Lei 85/a sack of 100 liters, meaning Lei 170;

(iv) 60 sacks of peat at the price Lei 20.24/ an Agro CS sack of 50 liters, meaning Lei 1,214.4;

(v) 15 sacks of garden ground of 50 kg each at the price Lei 23/sack, meaning Lei 345. Therefore, the total expenses with the substratum mixture needed to fill the 12,675 pots of 19 cm account for Lei 3,565.

(c) *Labor for transferring the plants from pots of 19 cm into pots of 36 cm.* Because only 240 plants/working day may, this means that all the 10,000 plants will be transfer in about 42 days. But, normally, this operation must be done in maximum one week.

For this reason, there are needed 6 workers, who are able to move 1,440 plants per day and in 7 days to finish the whole number of pots.

The total expenses for 1 permanent worker working 4 months (May, June, July and August) and for other 5 workers totalize Lei 11,900 for a tariff of Lei 100 for working day.

(d) *Watering the plants in pots of 36 cm.*

The arrangement of pots to be wet could be made in a square shape as in case of the pots of 19 cm. If we put 100 pots on one side of the square and other 100 pots on the other side, the surface of the square occupied by 10,000 pots of 36 cm is $S = 1,296 \text{ m}^2$.

But we have to take into account that the plants have more leaves, the vegetative mass is larger and larger, and at a moment they need more space to develop. In his case, it is required a larger surface of irrigation.

But, even under this condition, it is known that a plant in a pot of 36 cm needs about 2 liters water a day and 3 waterings a week for a period of 16 weeks (4 months) from May to the end of August.

Therefore, for the whole period of time, a plant in a pot of 36 cm needs 96 liters water, and for the 10,000 saplings it is required

96,000 liters or 96 m³, which at the tariff Lei 4.5/ m³, means Lei 432 water cost.

Having in mind, that it is needed as water to cover a surface larger than 1,296 m², it is not enough only one sprinkler.

In this case, it is required to buy an additional Kärcher sprinkler, PS 300, 703 m², with 30 m sprinkling ray, and 18 liters/min (1,080 liter/hour) water flow. The sprinkler price is Lei 66.59/piece at the market price.

The 96,000 liters water must be supplied by the pump of 1.4 KW and 5,000 liters/hour water flow, meaning that there are required 19.2 hours.

In this case, the electricity consumption is 26.88 KWh and at the tariff Lei 0.2734/KWh, it results Lei 7.35 electricity cost for pumping.

Therefore, the total expenses with watering the pots of 36 cm account for Lei 505.94.



Photo 2. *Paulownia* saplings of 50 cm height in pots of 36 cm.

Source: Original photo.

The expenses related to the production technology for producing 10,000 *Paulownia* saplings in pots of 36 cm are presented in Table 3.

Table 3. The expenses related to the production technology for producing 10,000 *Paulownia* saplings in pots of 36 cm

Crt. No.	Cost item	Total Expenses (Lei)
	MATERIALS	
1	Seeds	59.17
2	Cell trays	277.1
3	Small pots 7x7x8 cm	1,014
4	Pots of 19 cm	12,801.75
5	Pots of 36 cm	33,000
5	Peat substratum, of which:	1,008.00
	-for sprouting in cell trays	126.00
	-in small pots 7x7x8 cm	882.00
6	Substratum mixture for plants in pots of 19 cm, of which:	3,052.24
	-manure	1,521.00
	-sand	30.00
	-peat	1,032.24
	-perlite	170.00
	-garden ground	299.00
7	Substratum mixture for plants in pots of 36 cm, of which:	3,565.00
	-manure	1,800.00
	-sand	35.60
	-peat	170.00
	-perlite	1,214.40
	-garden ground	345.00
8	Watering, of which:	869.63
	-seeds and plants in cell trays	9.14
	-plants in small pots 7x7x8 cm	136.89
	-plants in pots of 19 cm	291.60
	-plants in pots of 36 cm	432.00
9	Submersible pump 1.4 KW, 5 m ³ /h	239.00
10	Sprinklers PS 300, 703 m ² , 30 m sprinkling ray, 18 liters/min water flow	133.18
11	Atonik biostimulator, of which:	5,390.70
	- for seeds and plants in cell trays	331.40
	-for plants in small pots 7x7x8 cm	5,059.30
12	TOTAL MATERIALS	61,409.77
13	SERVICES WITH THIRDS	
14	Electricity, of which:	1,182.81
	-for pumping water for seeds and plants in cell trays	0.16
	-for heating in spring season	1,168.00
	-for pumping water for plants in small pots 7x7x8	2.33
	-for pumping water for the plants in pots of 19 cm	4.97
	-for pumping water for the plants in pots of 36 cm	7.35
15	TOTAL SERVICES WITH THIRDS	1,182.81
16	LABOR	
17	Labor force, of which:	26,950
	-for working with seeds and plants in cell trays	9,850
	-for working with plants in small post 7x7x8 cm	2,600
	-for working with plants in pots of 19 cm	2,600
	-for working with plants in post of 36 cm	11,900
18	TOTAL LABOR	26,950
19	TOTAL PRODUCTION EXPENSES	89,542.58

Source: Own calculation

Therefore, for producing 10,000 saplings in pots of 36 cm, the production costs are Lei 89,542.58, of which the expenses with the materials represent 68.58 %, the labor costs represent 30.09 % and the cost with the thirds for electricity delivery represent 1.33 %.



Photo 3. *Paulownia* at 1.5 m height at the age of 8 months

Source: Original photo.



Photo 4. *Paulownia* flowers.

Source: Original photo.



Photo 5. *Paulownia* tree plantation at one year age and the farmer Eng. Liviu Sabau, the owner of SC Galya 3000 SRL
Source: Original photo.



Photo 6. *Paulownia* tree at two years from planting.
Source: Original photo.

Table 4. The comparative economic efficiency in *Paulownia* growing for producing 10,000 saplings in pots in the three variants V1, V2 and V3

Indicator	V1- 10,000 saplings in pots of 7x7x8 cm	V2- 10,000 saplings in pots of 19 cm	V3-10,000 saplings in pots of 36 cm
Production costs (Lei)	12,495.69	40,571.64	89,542.58
Production cost per plant (Lei/plant in pot)	1.25	4.06	8.95
Sale price	5	15	30
Income from sold pots (lei)	50,000	150,000	300,000
Gross profit (Lei)	37,504.28	109,428.36	210,457.42
Profit rate (%)	300.14	269.72	235.04
Net profit (Lei)	31,503.60	91,919.83	176,784.24

Source: Own calculation

The comparative economic efficiency in *Paulownia* growing for producing 10,000 saplings in pots in the three variants presented in this paper is shown in Table 4.

CONCLUSIONS

All the three variants to produce 10,000 *Paulownia* saplings in pots are profitable. This aspect is important for the farmers interested to develop such a business.

In case of V3, the length of the plant growing is about 8 months, and the production cost are the highest ones, accounting for Lei 89,542.58. The production costs are 7.16 times higher than in case of V1 and 2.2 times higher than in case of V2.

The production cost per plant increases from V1 to V3. In case of V3, the farmer can pay Lei 8.95 to produce saplings of 1-1.5 m height in 8 months. The production cost is more than double in case of V2, when there are produced saplings in 4 months at 50 cm height, and 7.16 times higher than in case of V1, when a farmer could produce a plant of 4 cm height in 1-1.5 months.

The sale price is higher when the plants have a higher height and are commercialized in

larger pots.

The income is 6 times higher in case of V3 compared to V1 and 2 times higher compared to V2.

Gross profit increases from V1 to V3, proving again that the plants with the highest height are more vigorous and better sold. The net profit has a similar increasing trend from V1 to V3.

The profit rate declines from V1 to V3, but it is enough substantial to prove that Paulownia tree culture is profitable.

Therefore, as a final conclusion, farmers interested to grow *Paulownia* for saplings could get a substantial profit in 1.5 months, 4 months or 8 months.

Paulownia could be successfully grown in Romania for saplings in pot. Also, it could be sold as cut plants with roots which could be directly planted in the field to develop plantations for fuel wood and mainly for furniture wood which is required for export and the best paid.

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