

## EQUIPMENT FOR EXTRACTING AND PLANTING EARTH BALE ROOT PLANTS

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### ABSTRACT

*Trees are one of the biggest organisms living on the planet and their role is extremely important, namely that to maintain the purity of air we breathe, improve water quality, prevent soil erosion, reduce noise level, ensure food, construction materials and eventually people comfort. Plantation and transplantation of trees by means of specialized equipment in comparison*

*with human force leads to an increased planting speed and higher yield, economically speaking. This paper is designed to present different constructive variants, at world level, of equipment for extracting and planting trees with earth bale at their roots, necessary for afforestation, landscape design, tree nurseries.*

### INTRODUCTION

Forests use to grow in all regions of the world where climate conditions are appropriate or there are not limits to hinder their development (e.g: fires, clearing, urbanization). Forests are huge producers/purifiers of the air we breathe. It is considered that a growing stage forest is able to „capture” millions of tons of carbon (even 5 millions of tons per hectare a year), thus limiting the excessive CO<sub>2</sub> content in planet atmosphere. Trees balance the soil fertility lack and, therefore, enable and protect the development of young plants, avoiding especially soil erosion determined by atmospheric agents, such as rain and wind. Tree roots compact the soil and prevent and/or fight against the effects of floods, landslides and other “natural” calamities. Forests influence the global climate because they generate less heat in the atmosphere comparing to other ecosystems; trees absorb the heat and, thus cool the atmosphere. Though, during the cold season, forests filter and make wind deviate, thus increasing the temperature. Starting from plants, different types of fuel can be obtained, from the classical log to put in the stove

up to vegetal coal and more sophisticated and efficient forms (pellets, briquettes, biomass, biogas). If they are appropriately managed, forests are important sources of renewable energy, mostly clean energy. [1] One saying from Ancient Rome said that „a squirrel could arrive from Hispania in Italica simply by jumping from one tree to another,, as the old continent was so full of forests. Nowadays, after centuries of thoughtless clearings, industrial revolutions and rapid technologizing, forests cover only 44% out of total Europe surface. Almost 80% from the European forests are owned by Russia. With a surface reaching about 1 billion of hectares, Europe forests represent 25% out of the total forests in the world. Recently, one of the greatest dangers that Romania forests are facing, is the uncontrolled cutting of forests situated on mountains and in wild areas, or the inappropriate manner of managing the private forests, thus having a negative impact on environment quality and disastrous consequences on medium and long term. Therefore, at the present moment, only 26% out of Romania surface is covered by forests, comparing

to the minimum percentage of afforestation imposed by international norms, namely not below 25%, if one considers to create the best conditions for people health. Today, we are situating under the European standard, Romania occupying the 13-th place in Europe. As concerning other European countries, the

percentages are the following: Austria is covered by forests in a percentage of 38%, Slovakia has 34.7% forest surface and Bulgaria-32.5%. The Northern countries take the first places: Finland (4.66 hectares per inhabitant), Sweden (2.88 ha) and Norway (2.32 ha). [2]

### **MATERIAL AND METHOD**

Trees are living beings that bring a lot of benefits such as air filtering, producing the necessary oxygen, supporting flora and fauna development, reducing soil erosion, conserving energy and reducing the impact of UV-B solar rays. The European priority objectives consist in preserving the forest patrimony, maintaining and increasing forestry biological value and productive potential of plantations of trees, fruit trees, dendrological material and also, improving the climate factors and life quality by enhancing the green space in localities and ensuring their sustainable management. Necessary time and techniques applied for producing high quality seeding material depend on each variety, soil and climate conditions. Thus, seedlings designed to fruit tree plantations require a formation period of 2-4 years, ornamental trees and shrubs from hardwood species- 4-7 years, and species of resin trees and shrubs require a bigger nursery growing period, having a slower developing rhythm than hardwoods and requiring a greater period of formation, namely, 7- 15 years. In this period, from agrotechnical point of view, according to species, 2-5 transplantations should be accomplished. For not hurting the plants, the relocation is made with an earth bale at tree root. Another important characteristic of coniferous species is their sensibility to transplantation, slower recovering of damaged root system, which frequently leads to the material loss after a period of 6-12 months after transplanting. These drawbacks can be

eliminated if during the nursery formation the material is transplanted at at most three years, by respecting the correct size of earth bale. From those said above, the conclusion is that the technology of producing seeding material comprises many operations and involves appropriate technical machines and equipment.[3] The whole transplanting process is an engineering work and requires a lot of resources and time. In order to perform the mature tree transplanting, specialized equipment appropriate to arboriculture is used. For smaller plants up to one diameter of trunk of 2.5 cm (1") transplanting is usually accomplished by spade. For the shrubs, trees or fruit trees with diameter over 2.5cm and up to approx. 10cm, the transplantation is performed by specialized machines. In table no. 1 below is presented the diameter of root earth bale dislocated, calculated according to trunk diameter. The main stages of tree planting are:

- choosing the location where the tree can develop and taking into account the necessary growing space. Certain trees, respectively fruit trees need more sun, others more water, etc;
- usually, the suitable transplanting moment is in autumn or winter, before or after the earth has frozen. When new leaves appear, the tree should not be disturbed;
- when digging a hole, the estimation of its size is very important. The hole should be big enough to include the tree root. The respective tree is extracted with root earth bale, that is calculated according to trunk diameter. [4]:

Table 1

**Calculus of dislocated earth bale together with tree root**

Den.No.	Trunk diameter (cm)	Coefficient	Earth bale diameter resulted (cm)
1.	Up to 1.3	20	26
2.	3÷2,5	18	54÷45
3.	2.5÷3.8	16	40÷60.8
4.	3.8÷6.4	14	53.2÷89.6
5.	6.4÷10	12	76.2÷120

- roots have to be attentively extracted, for not to be damaged and should be kept as little time as possible in fresh air. The transplanting process should be performed very rapidly. The roots should be kept humid until their relocation in the new place. When extracting the roots, it is necessary that a sufficient earth quantity covers them. Therefore, the plant chances to grow in the new place are increased, as roots are already fixed in the earth bale accompanying them. Bale root diameter, namely its depth can start from 20cm, 30cm, 45cm or up to 120cm.

- after placing the tree into the ditch created, earth should be add around the

tree, so that no air bubbles remain. Then, the soil must be wet and well drained so that the transplanted plant has the optimum conditions of growing.

Since 1950, specialists both from America and Europe were concerned by developing modern equipment designed to transplant the trees, therefore, nowadays, it is widely used in the whole world. At the present moment, on the global market are existing many manufacturers that design and produce special equipment of planting and transplanting large and small size trees, fruit trees, shrubs in horticultural and dendrological material nurseries, or related to landscape management, etc.

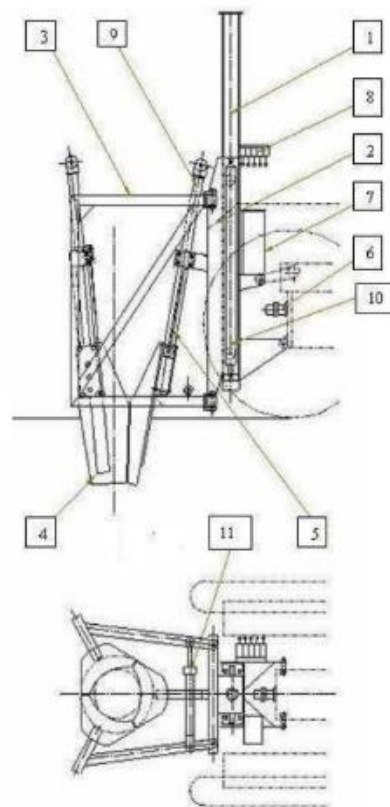


Fig. 1 - Equipment EXPLANT 500

For example, in Romania, with in IMNA Bucharest was designed and manufactured the technical equipment EXPLANT 500 (figure 1) designed to extract dendro-horticultural, ornamental or fruit planting material, with earth bale root, for transplanting it in green areas, plantations and/or formation fields in nurseries. At the same time, the equipment can be used for previously digging the holes, where the planting material either with bare root or earth bale root, is going to be transplanted. Machine for extracting dendro-horticultural material with earth bale root is carried behind the tractor, being mounted in the place of lateral rods. The machine working parts are of hoe type, mounted on supporting arms with possibility of sliding by means of a sliding system. Hoes assembly vertical movement is ensured by a sliding body. The active parts are moved by means of hydraulic installation, driven from the aggregate tractor. Equipment designed to extract dendro-horticultural material with earth bale root is schematically shown in figure1, being carried behind the 45 HP tractor, mounted in the lateral rods place. Active parts are driven by the machine hydraulic installation from the aggregate tractor. Main components of the equipment are: - guiding frame (1); - sliding body (2); - hoe supporting arms (3); - hoes (4); - hoe guideway (5); - hydraulic pump (6); -oil tank (7); - distributor (8); - hydraulic cylinders acting the hoes (9); - lifting hydraulic cylinder (10); - hydraulic cylinder driving the hoe supporting arms. (11).

At international level, the Canadian company DUTCHMAN INDUSTRIES CO manufactures a series of equipment of hoeing and extracting/planting trees and seedlings. The manufacturer makes available a wide range of equipment [4].

One of these is the equipment for hoeing and planting carried in front or behind by a vehicle (tractor) or small and medium sized loaders (Bobcat). The working parts of hoe type are hydraulically driven and have different geometrical shapes and

approaching angles. They are mounted on supporting arms and are able to slide by means of adapters. The following types of digging and planting trees are presented:

1. Range of equipment with conical hoe (models: 240i(o), 280i(o) 330i(o)), Equipment is carried and its working parts, namely the hoes are straight of cone trunk type and an approach angle of  $22^{\circ}$ . This will allow a more straight cutting of root earth bale and a wider hoeing. Equipment is ideal for digging trees with small depth roots and also for working in a loamy soil. The hoe height can range between 61 cm (24 in) and 83.82 cm (33 in).

Model 240i fig. 2 – is used for planting in narrow areas the coniferous trees with length up to 1.22 – 1.52m and maximum thickness of 6.35cm, with an earth bale height comprised between 51-61cm. Mass of equipment is approximately of 900 kg. Equipment is carried, appropriate to small sized loaders(bobcat).



**Fig. 2 - Equipment DUTCHMAN 240i [5]**

2. Range of equipment with semi-cone trunk hoe (models: 200 o, 240i(o), 280i(o) 330i(o), 360i, 420i, 450i, 500i, 540i, 650i, 720i)

Equipment is carried and its working parts, namely the hoes are narrower and have an approach angle of  $25^{\circ}$ . This will allow a restricted hoeing of root earth bale, but the tree will remain straight. Due to the fact that hoes are narrow this allows a better penetration in loamy soils. Hoes height from this range can be from 50.8 cm (20 in) up to 203.2 cm (80 in).

Model 200o (figure 3) – is designed to extract and plant trees, little shrubs of

45.72 – 50.8 cm height. Model 200o – has an approach angle of hoe of 25° slope:



Fig. 3 – Equipment DUTCHMAN 200i [5]

## RESULTS AND DISCUSSIONS

Within the laboratory and field tests, were analyzed the possibilities of using the equipment of extracting earth bale roots, EXPLANT 500, for digging holes and planting.

During the tests of equipment of extracting earth bale roots in aggregate with 45 HP tractor, U445 DT, were analyzed the indexes of energy and exploitation when performing the following operations: - digging holes for planting; - extracting ornamental trees with earth bale root. In working conditions similar to those of experiments designed

to find out the working qualitative indexes, the main energy and exploitation indexes, were estimated. The work consisted in taking out the plants (dendrological material and shrubs from fruit trees) with earth bale root and leaving them on the soil, for wrapping the earth bale, at a distance of 2-3 m from the extracting place. In table below are presented the „energy and exploitation indexes of aggregate made of EXPLANT 500 equipment and tractor U 445 DT„.

**Table 3**  
**Energetic and exploitation indexes of working aggregate comprising EXPLANT 500 equipment and U 445 DT tractor**

Index	M.U.	Value
Hourly fuel consumption	Kg/h (l/h)	4.18 (4.78)
Coefficient of utilization of shift time	-	0.54
Coefficient of technical safety	-	0.97
Coefficient of technological safety	-	0.96
Coefficient of reliability	-	0.94
Real working capacity	no. plants/hour	25
Working capacity per shift	no. plants/shift	110
Fuel consumption for 100 extracted plants	Kg (l)	<b>31.28 (35.30)</b>

## CONCLUSIONS

Mechanized transplantation of trees is more economical and productive than that manually performed. The planting equipment yield depends on the model and type of machine used, planting material (tree size) and land.

Advantages of mechanized transplantation operation of trees are:

- The seeding material in nurseries is more efficiently produced, by diminishing its cost prize up to 30%, as

- a single equipment replaces the work of about 20 persons;
- The conditions for obtaining seeding material of high quality are enhanced, the transplanting losses being minimum and the cost prize diminished by 20%;
- Working conditions in nurseries are improved by reducing the manual labour and, implicitly, the physical effort;
- New jobs are created at economical agents interested in manufacturing the equipment proposed to be achieved;
- Sustainable development conditions and a high living standard of villages, small and big towns, where the land building occupancy is very high, are ensured. This is achieved by enabling the extent of surfaces covered by green spaces;
- Opportunities for creating new economic activities in terms of services performed during winter holidays, such as delivery of potted fir trees, that afterwards can be replanted;
- Rural development chances by reducing the unemployment and migration from village to town are enhanced.
- Environment factors are improved, pollution and quantity of CO<sub>2</sub> are diminished by ensuring the growing conditions for green space surfaces; Ensuring the improvement of slope fields, less fertile and prone to erosion and capitalizing them through fruit tree cultures or other plantations with role of environment protection.

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