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# TEHNOLOGIE INNOVATIVA DE INFIINȚARE A EXPLOATAȚILOR POMICOLE PE TERENURI DEGRADATE ÎN PANTĂ ȘI TERASATE

# ORCHARDS INNOVATIV PLANTING TECHNOLOGY ON DEGRADED LAND SLOPING TERRACE

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**Abstract**

**In context of fruit sustainable technologies was developed the orchards innovative planting technology created to be used especially on heavy environmental conditions, respectively on degraded lands. Nowadays, the slope terrains are a very important topic especially in the in hilly and mountainous areas, where large areas have been deforested, and in this way land degradation phenomena occurred with serious social and environmental consequences on large areas. In order to mitigate and stop those effects, from technologic point of view, must be made specific land restoration works, like terracing, in order to increase land stability and to replant locally vegetation (reforestation, to establish orchards or vineyards in hilly areas). In this paper will be presented the results obtained in experimental land field when was used the innovative technology, fact that demonstrates its usefulness in the community and degraded lands owners, and also to: encourage the economically sustainable activity, establishing orchards and to add value of the degraded lands.**

**Cuvinte cheie:** plantarea puieților, plantare mecanizată a livezilor, terenuri degradate, tereluri terasate.
**Keywords:** tree establishment, orchards mechanization planting, degraded land, slope terrace

## 1. Introduction

Taking in consideration that is a safety national security subject, respectively mitigation and prevention of natural calamities, the researchers from INMA institute have developed a green infrastructure innovative planting technology on degraded lands, that can be also used successfully also to establish orchards and vineyards. (14)

At European level, this project meets the objectives of National Forestry Program -PFN, in order to mitigate the delicate environmental issues and to support forest and tree sector in order to implement the means of sustainable environmental policy's and a proper management, especially on slope degraded land areas. Those directions were drawn during debates from Rio de Janeiro International Conference from Forest Protection held in 1992, and in Europe (at Helsinki in 1993; at Lisboan in 1998 and at Vienna in 2003) and were discussed the green infrastructure importance and role to strengthening synergies for sustainable green infrastructure management. (12)

In Romania, lately, were identified large areas with degraded lands and pollution sites, not taking in to consideration that the deforestation activities are practiced in wild or private forest areas, and measures to prevent environmental degradation are almost non-existent, leading to an increase in the negative impact on the quality of the environment and disastrous consequences in medium and long term that will be borne by future generations. (Damina I., 19969, Milasan at al., 2011, 12)

Another phenomenon that is spreading in Romania it is the forsaking of fruit and wine plantations, due to lack of manpower and performant equipment that can fill this gap, especially for maintenance, harvesting and sorting operations.

A particularity of the degraded lands is a low soil stability due to erosion (surface or depth erosion) and for this reason is recommended it is recommended to do rehabilitation works, namely the specific terraced works that are flowed by the planting works, which are generally hand-made. The terracing works are part of land and agrarian improvements policies applied on territory organization, in order to implement sustainable development methods to land stabilization taking in consideration the erosion factors that could cause the loss of stability over time. (Palaghianu at 2011-2012, Mircea at al., 2016)

When the degraded lends are positioned on high slopes, the terracing works have a certain succession due to the fact that the soil layer is thin and generally poor of nutritional compounds.

Slopes planting works are conditioned by a series of operations designed to soil preservation and improvement, as well as seedlings establishment and growth, but also of tree development and fruit-bearing. These are: waves, coastal channels, terraces, etc.

Usually, the earth waves are generated on 2÷30 % slopes, following the level curves. The with can be in range of 2÷4 [m] in accordance of inclination angle (see Table 1) at a distance of 6 [m] and at a high range of 0.26÷0.60 [m]. (12)

Horseshoe earth waves, are made of well-beaten earth and have a horseshoe with a height range of 25÷30 [cm], a slope length of 2÷2.5 [m], a bottom width of 0.5÷0.7 [m], the ends have 0.25 [m] and a 3 [m] aperture, those are recommended for slopes of 2÷35 %. These formations can hold between 0.03÷0.05 and 0.02÷0.25 [$m^3$] of water. The terraces generated on slopes 15÷35 % are made from ground masonry and those with a greater slope with pavement masonry. On land terracing process it must be taken in to consideration the following factors: the established and maintenance technology (man power works or mechanization technologies); the type of seedling material established on orchards or vineyards; the soil quality and the climate conditions.

Main mechanization technologies applied on this type of structures are implemented the technique of costal terrace terrain, in these conditions the terrace dimensions are larger and can be separate by slope parcels (road terraces) or with narrower successive strips, so to ensure the rooting and plant development optimal conditions, see Fig.1.

Another important factor that must be taken in to consideration is the lack of the labor in these kinds of works and the fact that is time consuming process, fact is not a positive aspect if we take in to consideration the climate changes that which directly influences the optimal period of setting up vegetation and the seedling rooting phase. For these reasons it is adequate to use mechanization technologies to establish orchards and vines, so that in the first establishment year to register a good percentage of raising and the rooting system to develop in order to create a strong structure and to create a soil supporting structure around it.

In this case the plating plan must be made so to assure the necessary saddling developing space and resources, respectively 4/6 [m] or 4/7 [m] between the seedlings, sow at 4-th and 5-th year of development to interconnect and to create a support network for the degraded soil, this considerations are made in the case the seedling material is young, but if it is considerate to plant plants that are with earth bundle – near to the final year of development, this process can be shortened but requires a lot of work.

Sometimes the planting surface of the terrace must be inclined inside in order to collect the rain water and to direct it on the plant rooting system and in some cases the fruit trees can be alternate with fruit shrubs or grass according to several planting plans, so to use mechanization reap equipment (10)].

Taking in to consideration the above considerations the INMA had develop an innovative planting technology designed for degraded lands, Fig.2.

## 2. Material and methods

The seedling planting process, adequate to degraded land working conditions, must to respect the next requirements:

- to process the degraded soil from the terrace as: subsoiler and earth grinding with „L" shape blades horizontal milling for a strip of 0.6 ÷1.5 [m] with and 6÷25 [cm];
- terrace earth modeling and leveling, operation that also include the parameters to create the counter-slope. The leveling blade can be chosen and adjusted to meet the technical requirements: working width, tilt degree, number of passes;
- the hole execution must be made in accordance of seedling material specifications (namely the hole deep and dimension) and the auger driving to be made by the operator in accordance of soil concinnity and compactness.

All the technical equipment's must be trailed by small gauge power machines (gauge, wheelbase, weight, etc.) as: monocultures or tractors, especially when it is working for lands with 5 ÷ 15 $^0$ slopes.

In Fig.3, is presented the innovative seedlings planting technology where was used as power drive unit a BERTOLINI 318 motocultivatore (engine power of 19 HP) that will work with several equipment's: a horizontal earth mill - FM, a leveling blade - LM and a drilling equipment -BM. The last equipment's were designed by INMA researchers so to be easily adapted to hard working technical requirements (terraced degrade lands).

The FM is a normal earth mill that has the role to prepare the terrace degraded soil, namely to soil decompaction and grounding, and also to incorporate the vegetal scraps (operation very important to equilibrate soil composition). The motocultivatore powers the horizontal rotor type with L-shaped curved blades, made of manganese and silicon alloy steel.

The LM equipment was designed so that the active soil modeling element position to be adjusted in accordance with terrace technical specifications (the inclination working, orientation on driving direction, leveling level, etc.). The aggregate motocultivatore and LM it is recommended to work successfully on terraces with sanded or previously treated with earth milling degraded soils. The earth milling operation has the role to reduce the blade advance force, facilitating the operation of degraded land modeling and low fuel consumption. Thus, the leveling operation requires lower energy consumption and facilitates the accumulation of rainfall necessary to develop the green infrastructure to be installed and eventually upstream materials. Sometimes, the FM equipment can work after the leveling phase, in order to work uniformly on terrace surface, to ensure water permeability in the soil and to reach the seedling root system, Fig.2.

The BM - this device generates the seedling planting holes taking in to consideration the fact that nowadays the seedling material can be procured with earth bale or without, the drilling equipment was designed to work with several types of augers (respectively for a large range of dimensional auger type or with complex construction, Fig.2).

The technologic process was tested on artificial terrace in the most difficult conditions, a generated terrace with 30 $^0$ slope, 1.5 [m] with and 1 [m] high, see the orange arrows from Fig.3. The testing period was in spring at 15 $^0$C working temperature and high humidity, the same conditions that are usually made this type of works in orchards and vineyards – open air normal conditions.

Also, the experiments were conducted on 30 $^0$ slope terrains without terrace and on smaller slope for BM equipment, Fig.4 and 5. During those phases was used as power source the smaller capacity power source – the 19 HP motocultivatore in order to validate this technology in accordance with project objective and other exploitation conditions slope and field terrain and also in greenhouses conditions (this application is intended for intensive fruit production in controlled environed) Fig.6.

## 3. Results and discussions

Usually the results of technology implementation can be seen after a period of time at least 1 year- Fig.8, period on which the seedlings develop the root system and the crown, depending on the branches and foliage development, it can be established whether the roots have a normal evolution. The results obtained after implementing this innovative technology are shown in Fig.7 and 8. (Bogdanof et al., 2016 and 2017, Visan et al., 2016)

As it can be seen in Fig. 7 the fruit trees seedling planted on flat terrain had a good development and in the second year of planting were ready to enter the fruit. Instead the seedlings planted in greenhouse conditions, namely the dwarf cherry, after 1 year, had a slow development.

The BM was implemented an “auger positioning system designed to achieve planting dwelling in sloping lands”, technical solution that was subject of a patent application and tested in field experimental conditions and in exploitation. (1, Bogdanof et al., 2017). Also due to experimentation activities were patented other two technical solutions necessary to implement on BM equipment in order to increase its adaptability and functionality, namely: “deviation compensation device of drilling operation that uses a guided auger by a parallelogram mechanism” and “system for rapid mounting and damping the axial shocks of the drill for making the planting holes” (2,3). All these patents were presented at national innovation fairs and obtained third place, bronze medal.

If this technology is used in greenhouse conditions, must be taken special measures to ensure optimal ventilation conditions and to make oxygenation frequent breaks, because it was noted that is a real risk that the operator will become intoxicated with exhaust gases.

## 4. Conclusions

The fruit tree innovative technology dedicated for slope degraded lands present a height level of innovation because it can be implemented three patented constructive solution that which increases the field of applicability and adaptability to all environmental conditions. In this paper is presented the technology in which the BM equipped with the first innovative technical solution (Bogdanof at al., 2016), equipment that was successfully tested on experimental field, occasion on which was also validated,

This technology will be tested also, in other hard environmental conditions, in the near future because its presents the flowing advantages:

- this technology corresponds to the real need to rehabilitate degraded areas with a high slope (max. 30 $^0$) and can help to establish orchards and vineyards, and all kind of green infrastructure to increase ecological and economic stability and sustainability, eliminate sources of pollution and reduce risks of natural disasters;
- to design new innovative equipment’s to satisfy the technological need and to substitutions of human resources in the orchards and vineyards management works and also to mitigate the erosion impact on slope landsides;

- to stimulate the slope degraded lands owners to establish green infrastructure to mitigate the degradation phenomenon, to add value to the property and to register a suitable economic activity by using seedling planting technology;

- rising the fruit tree and vine establishment productivity at 40 ÷ 50 % so that this operation can be registered in the optimal planting period, the period which in recent years is shorter due to the climatic changes;

- creating new the horticulture, forestry and green spaces maintenance, estimations that will led to an increased employment in hilly areas with approx. 15%;

- rising the exploitation level of slope degraded lands by planting high quality fruit shrub species and trees, resistant to severe climate conditions, have a high regenerative capacity with pest resistance.

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***Tables and figures***

**Table 1. Earth wave technical construction data (Visan at al., 2016)**

| Land slop (%) | Waves distance (m) | High waves (m) | Land slop (%) | Waves distance (m) | High waves (m) |
|---|---|---|---|---|---|
| **2** | 40,5 | 0,81 | **9** | 16 | 1,43 |
| **3** | 28 | 0,83 | **10** | 15 | 1,5 |
| **4** | 27 | 1,11 | **11** | 14 | 1,55 |
| **5** | 23 | 1,15 | **12** | 13 | 1,57 |
| **6** | 20 | 1,19 | **13** | 13 | 1,7 |
| **7** | 19 | 1,25 | **14** | 12,3 | 1,7 |
| **8** | 17 | 1,40 | **15** | 11,7 | 1,75 |

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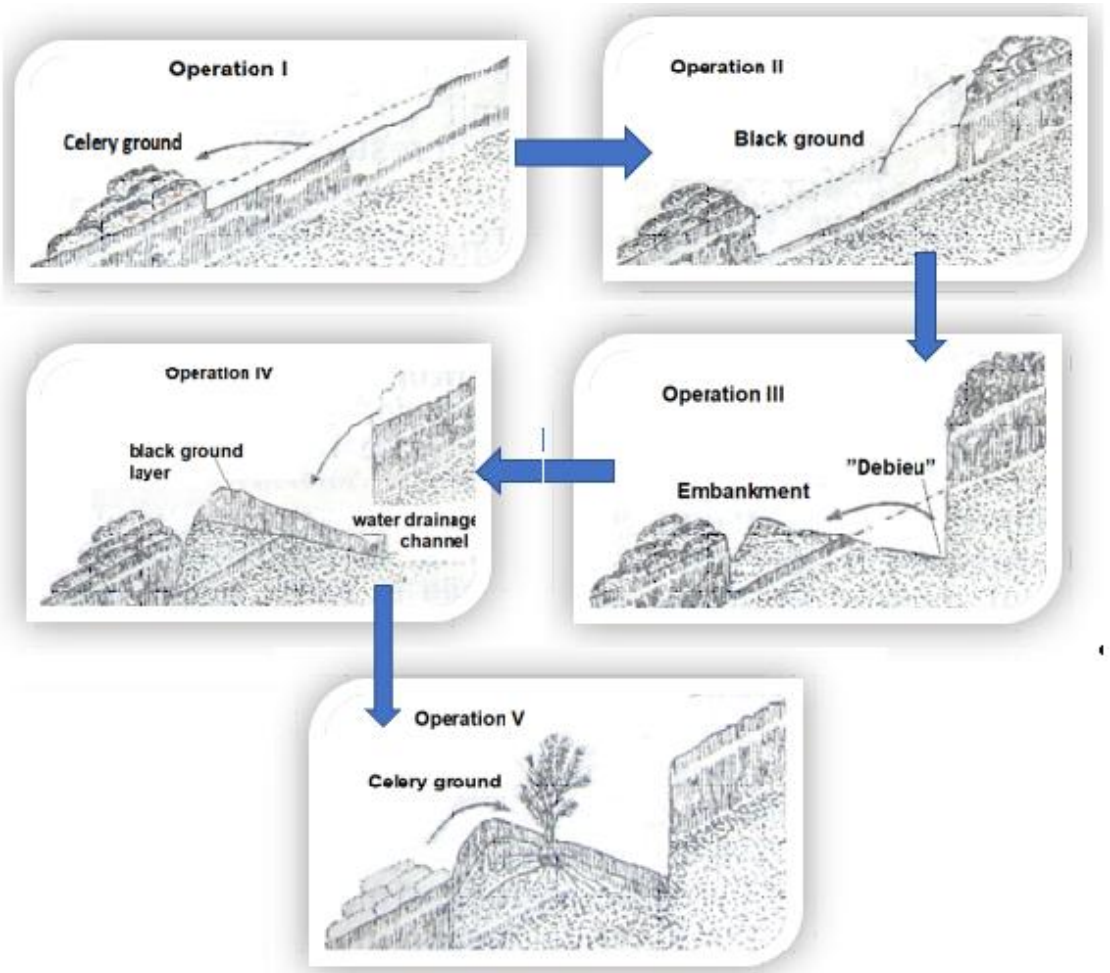


**Fig. 1. Generation terrace method for fruit tree planting.**


**Fig. 2. The innovative technology and and the succession of working equipments designed for degraded lands (Visan et al, 2016, Bogdanof et al., 2016)**

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**Fig. 3. Planting innovative technology on 30 $^{0}$ slope terrace with degeaded earth – photos from experimental field (Visan et al., 2016)**

**Fig. 4. Planting innovative technology on 30 $^{0}$ slope terrain with degraded earth – photo from experimental field**

**Fig. 5. Planting innovative technology no slope terrain – photo from experimental field**

**Fig. 6. Planting innovative technology on greenhouse condition – photo from experimental field**

**Fig. 7. Planting innovative technology result on flat terrain– photo from experimental field after 2 years**

**Fig. 8. Planting innovative technology on greenhouse condition – photo from experimental field, after 1 year**