

ENVIRONMENTAL REHABILITATION OF EXCESSIVELY ERODATED SLOPE TERRAINES USING INNOVATIVE AFFORESTIZATION TECHNOLOGIES

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Abstract: *Excessively eroded slope terrains represent at national level a high ecological and economic risk, for this reason this the governmental institutions show great interest, because in conjunction with climate changes can generate ecological calamities. To keep us in line with European strategies the government financed several research programs to develop innovative technologies and equipment necessary to apply the rehabilitate measures to the high risk calamity areas. Taking in to consideration that, the eroded terrains are more and more present due to illegal tree cutting, and the fact that has a great impact on social and economic point of view, it is necessary to develop several afforestation innovative technologies designed for degraded slope lands and specific innovative technical equipments, which can be effectively be combined, so as to allow their adaptation to: increase the forest fund in high risk areas for stabilise the terrines, and to establish protection forest belts for decrease air pollution with dust.*

Keywords: *eroded terrines, environment rehabilitation, afforestation technology, slope terrain,*

1. The impact of afforestation technologies of degraded lands

Internationally, afforestation operation aims to be mechanized and adapted to the toughest environmental conditions, therefore it is required achievement of innovative technologies and equipment suitable for degraded soils, namely the eroded slope terrain.

Current stage of development in our country is dictated by major agricultural and horticulture machinery, equipment and technology development companies.

The afforestation field is rarely encountered because developed countries preserve forested areas, especially areas with a high disaster risk, and also have a policy to discourage excessive cutting, in spite of that, the trees cutting sector has grown rapidly and woodworking equipment's show a high level of innovation.

The development and greening the environment trend is growing, but because those two terms cannot be actually matched, it was created the concept of green infrastructure. This concept has been approved internationally by the most developed countries in the world (USA, China, Arab Emirates, France and Nordics) and it has several objectives:

- Reducing the level of powdery substances from the atmosphere and noise pollution;
- Reducing land degradation level and to combat excessive temperatures;
- Reducing the massive earth movements and preventing environmental disasters
- To make passages for animals' mobility in protected nature reserves;
- Creating depollution methods for historically contaminated sites (sites mining, petroleum, chemical, industrial, domestic, etc.);
- Creation of green infrastructure to decontaminate surface polluted waters, etc.

At European level, the afforestation presents a priority because it has a good impact on the environment at medium and long term.

Considering the magnitude of social movements for environmental protection and the work of NGOs in the field, has developed a new sector of activity in landscape design and green

infrastructure. In order to preserve the specific area and flora and fauna where develop several types of trees transplant equipment's and drilling machines.

The ecological disaster, according to some journalists, it is caused by private forests owners who have triggered the slaughter of Romanian forests. [1]

The coordinator of WWF forestry programs, Radu Vlad has confirmed, that there is a tight correlation between the illegal cuts red code and the floods red code, but also that "Not accidentally, the degradation of forests and illegal cuts are considered a threat to national security".

[1] Therefore, the biggest dangers that Romania forests are confronted with are the destructions generated by uncontrolled cuts from wild mountains areas, both state and private forests property, which are poorly managed and have a negative impact on environmental quality and disastrous consequences in medium and long term.

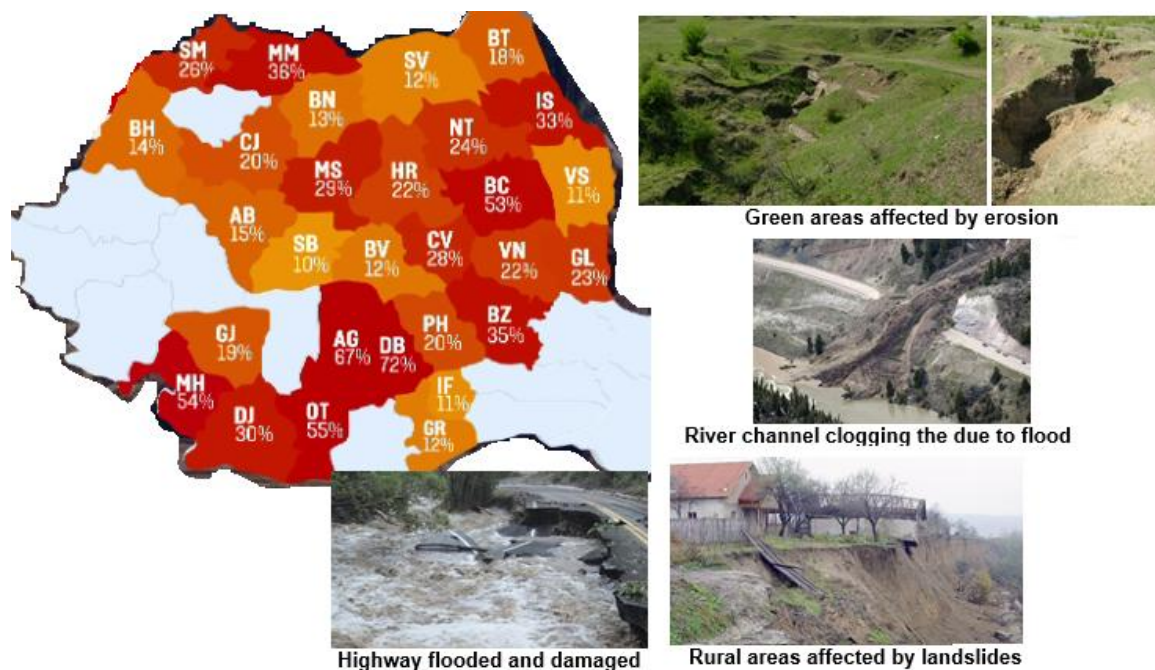


Fig. 1. Map of risk areas and consequences of slope land erosion [2]

A necessity is to increase the green areas at the border; first of all to rehabilitate the area affected by erosion and drought, as well as lowering the air pollution level and re-establish the local flora and fauna.

If the extreme weather events are emphasized, can happen negative consequences for economic, social and environmental as well: substantial reduction of agricultural production, reducing soil fertility, removing partial/total agricultural areas affected by erosion and landslides, reducing the capacity flood drain, clogging riverbeds, etc.

This consequences must countered by measures and medium term long as establishment of agroforestry curtains and terracing the degraded land sloping. Methods that where demonstrated their effectiveness and protecting the agriculture fields, the transport infrastructure (highway, European and national roads) or human settlements (village, parish, town). These measures can be applied with large human labour for a long time period or with adequate mechanized technologies.

2. Innovative afforestation technologies

The afforestation technologies of slope degraded lands is very difficult due to: high soil instability, different soil composition, mixture of green infrastructure planted (trees, shrubs, conifer, fruit trees),

whether conditions and the particularities of the area. The green infrastructure must be chosen in accordance with: type of erosion (wind or water erosion); area particularities; soil type and also with area potential.

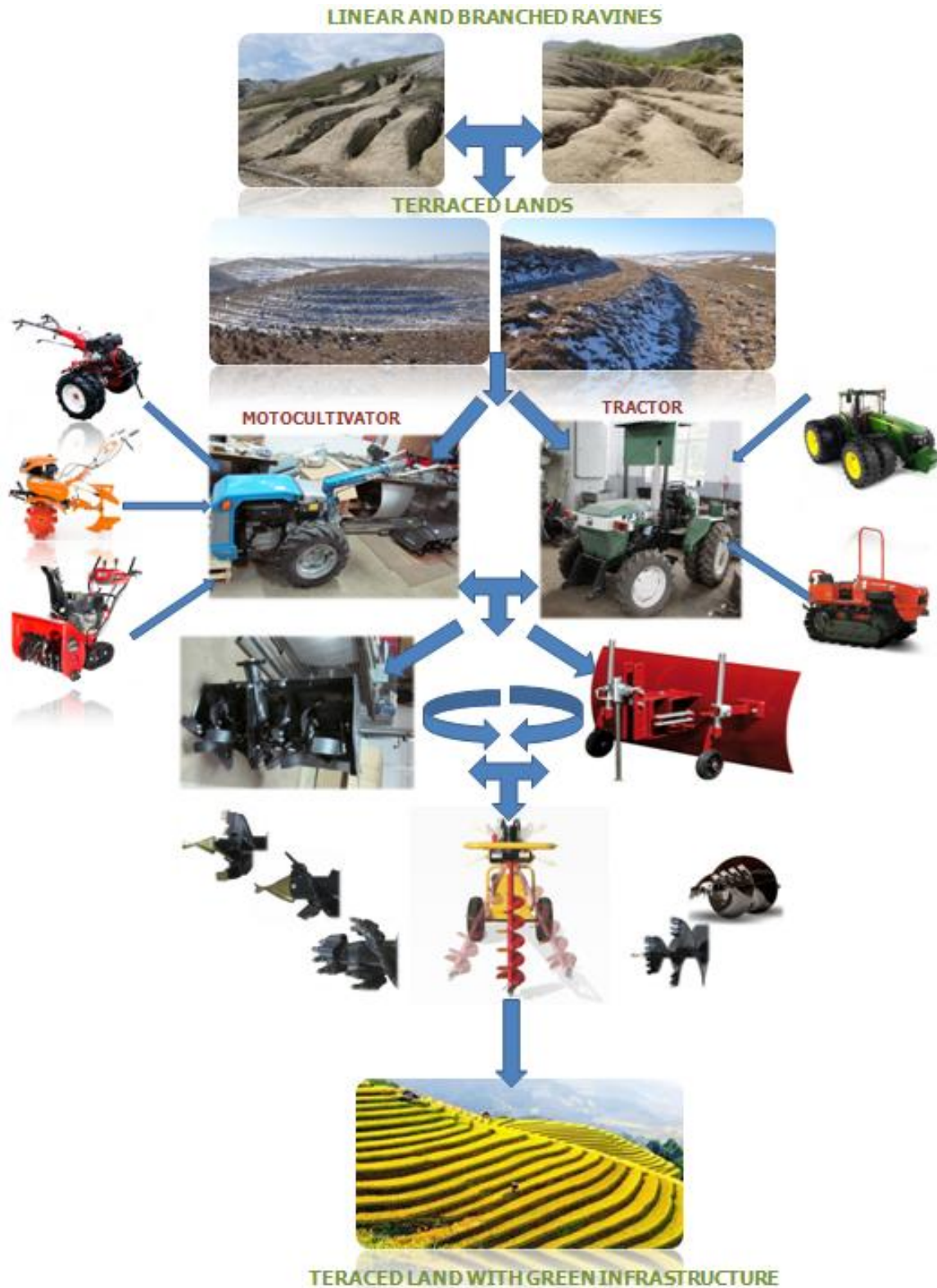


Fig. 2. Afforestation innovative technology for the of degraded slope lands.

In scientific literature the slope degraded lands, especially those that are high eroded, must be terraced in order to increase the soil stability, to prevent ravine regeneration and to collect the water precipitation and the snowfalls. In this way it is encourage to infiltrate the water in the soil in loose strips of land in the areas of the terrace is favoured, this way ensuring an additional pluvial water supply for the saplings planted on those. The terraces can be dimensioned depending on: the water volume that comes from precipitations; the terrace air flow, the number of saplings planted, as well as the terrace platform counter-slope, which can be accomplished of 70 - 80 cm wide, placed on a distance of approximately 2 m from the symmetry axis of terraces. The volume of water that it can be retained by them is scientifically proven and the indicated values are: for a 10% terrace counter-slope it can collect approximately 17 l/m² and for 15% counter-slope respectively 25/m². [3]

Land terracing works are part of the series of works with land and agro-forestry development character within the territory systematization, for land stabilization in accordance with the factors that could cause this process in time. [3] From a scientific point of view, it was proven the efficiency to make terraces with 0.6 to 1.5 m wide, alternated with grass strips accomplished with mechanized technologies. [4]

The terrace construction is made in accordance with geographic conditions and climate conditions, usually their construction must take in to consideration the technology used to establish the green infrastructure, especially when is created the slope inclination (usually the counter-slope for light eroded terrains is 0...15 ° and for high eroded 15...30 °), because their wide must be between 1 and 1.5 m and the equipment's power sources used do not damage the terrace structure and to assures optimal operator conditions.

Usually the establishing green infrastructure process take place in spring and autumn, period in which the soil stability is mostly influenced by weather condition and the water quantity accumulated in the soil. In order to operate the equipment's in optimal conditions (no slipping, no diving or no mudding) must be equipped with twin wheels, spikes, metal wheels or tracks. Also for all these reasons, it is recommended to use only small size power sources, tractors or motocultivators, because they have small gauge and lightweight.

In fig. 2, is presented the equipments used in this technologies are agriculture machines designed for hard conditions and their sequence is established at the scene, respectively milling and levelling, in accordance with soil structure, compaction level and terrace counter-slope.

Depending on soil compaction level is the passes number of the milling and levelling equipment's, the same thing happens when the terrace counter-slope is over 15 °.

Nationally, can be successfully implemented in this technology some agricultural machinery such as tillers, tractors and other devices that can be adapted to these types of work, such as: horizontal mills, levelling blades and drilling devices.

3. Consideration regarding the equipment's used in afforestation technologies

The tractors used in this afforestation technology, at national level, is 200 DT model Tractor, manufactured by HART S.A. company at Miercurea Ciuc, designed to work for slope terrains with maximum angle of 20°. The technical characteristics are: power steering, outlet power, tie rods, 2 hydraulic power source, 4x4, 4x2, 8-speed forward, 4-speed back, wiring, electrical socket, counterweights, ARO Brasov motor, two pistons, diesel consumption 2 l/h, 20 HP, 15 kW, and a three-cylinder Honda engine.[55, 56]

The newest professional motocultivators can rich 18 HP, as models manufactured by Bertolinii, that are delivered with horizontal earth mills that also can be joint to small tractors.

One of the most important equipment from this technology is the horizontal earth mill, due to its design and blades can be easily adapted to work in hard working conditions (soil with rock fragments). The blades that are usually used are the L type, because they can work at wide range of depths: for large depths (between a = 6...25 cm) and for field preparation (between a = 6...15 cm). The rotor diameter is also chosen depending of type of work that must realise, for soil preparation $\Phi=350...550$ mm and for hard conditions $\Phi=550...800$ mm.



Fig. 3. 66 cm earth miller designed for PRO TRAC motocultivator [93, 94]

The number of blades and their placement of the miller rotor is very important because depends the crust splitting level and the earth crushing. In forestry area it can be successfully used the earth misaligned millers, Fig. 3, made by APESA Company.

The vertical drillers can also work in aggregate with tractor can especially when the drilling holes are positioned on bough sides of the central tractor axis, especially for slope terrenes. The devices which are equipped the standard models are: oil bath gearbox; shaft with protection; 3-point adjustable mounting system to adapt to the tractor; vertical control system to maintain squareness; screw to control the lateral movement; cross slope compensation system. The drilling equipment, presented in fig. 4, works at maximum depth of 1000 mm and the auger diameter is between 250...600 mm, this equipment works in aggregate with tractor and has 3-point connecting system and also can be successfully used in agriculture to establish forest belts and fruit-growers (fruit-trees plantation).



Fig. 4. AGROSEZ and EUROMARKETING drilling equipment's [5, 6]

In the next paragraph are presented most appropriate augers models, from technical point of view. The drilling equipments are provided with dedicated augers, especially designed for various kinds of degraded soil and the most representative augers are made by McMillen and Skid Steer, Fig.5.

A model dedicated for light and moderate soils are HDF. Instead the HDC model is designed for hard working conditions as: compact soil, clay soil, asphalt, frozen soil and fractured rock. This model it is made from cast steel and it has double hardened coils (on the outside edge) that are ended with chisels for depth. The boring tip is "fishtail" shaped. The HDR auger has a single hardened coil (on the outside edge) that is ended with steel tines shaped bullet, the distance to the active element is 75" and a 2" hexagonal boring tip with 4" length. The HTF auger model is especially created to plant trees and shrubs.

The Eterra Cast Bits auger, made by Skid Steer Company, has a working domain between 4" and 36" and it is equipped with removable chisels, in order to work with degraded lands as: land with rocks, boulders, lava, or mixing zones with concrete or broken solid rock into large pieces.

When used power machineries and equipments with low ground clearance, it is necessary to use

versatile augers with short coils, who works sequentially on reduced depths. From this category is presented the Eterra Cast Bits auger, which is provided by the supplier with an extension shaft such that it can be adapted higher ground clearance to equipments and to increase the working field.



Fig.5. Dedicated augers used by drilling equipment's for degraded soil. [7, 8]

4. Conclusions regarding the afforestation technology

The two operating manners of the innovative afforestation technology, respectively with tractor and with motocultivator are similar, but due to hard working conditions it can be state that:

- The size of a tractor is bigger than that of motocultivator, fact it must be taken in to consideration when the terrace counter-slope is high and the soil is unstable;
- The power developed by the tractor is higher than the motocultivator, but nowadays this difference is it can be easily minimized;
- The motocultivator can be fitted with maximum two independent PTOs, for the most performing models, one can work in stationary and one in movement;
- The tractors have a mechanical transmission, hydraulic and pneumatic power drivers;
- The motocultivator manoeuvrability is higher, but the operator can be placed in difficult working situations, especially when the soil is very degraded and unstable;
- The tractor can have more automation systems implemented in than the motocultivator.

For working counter-slopes bigger than 25 °, it is not indicated to use tractors as power source, because there are more risks during operation, as:

- The risk to deteriorate the angle of the terrace achieved on degraded lands due to the probability that the tractor resistance frame came in contact with terrace structure and to generate landslides;
- The risk of accidents during the equipment operation and equipment deterioration, especially in the situation where the soil is unstable (high moisture or sandy soil) or under the action a higher weight.

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