# PREVENTING AND CONTROL OF SOIL EROSION ON AGRICULTURAL LANDS BY ANTIEROSIONAL SHELTER-BELTS

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***Abstract***

*In Romania, one third of territory is affected by soil erosion process, doubled by a dry trend in climate, therefore, there are necessary ample measures of antierosional works. Among these, antierosional forest belts and plantations establishment represent a major approach.*

*The present work has as the main objective to Romanian bibliographically reference the types and establishment modalities of antierosional works, as well as main areas where they have been established. In recent observations, we have analyzed the behavior of the tree species, forest belts spatial design and its antierosional efficiency in different zones from the country. Antierosional forest belts are to be established on contour lines of the affected or predisposed to erosin versants. Space between belts is determined based on the criticial erosion distance, as varying between 100-150 m to 300 m, depending on the erosion degree, lands topography and land use. Belts width is set upon both rainfall and land features, as varying between 10 - 20 m up to 60 m on strongly eroded slopes.*

*Regarding the species assortment, the most efficient, both in terms of halting erosion and stand evolution, shows the mixes of principal, secondary and shrubs woody species, in a designed spatial structure with tallest tree species centrally positioned, while other species are placed toward the edges of belts in descending height order to bushes on both sides. Most promising tree species for further use in the composition of the antierosional forest belts are: oaks, sycamore, maple, ash, common walnut, cherry, locust, honey locust, flowering ash, Siberian elm, field maple, Tartarian maple, osage-orange, oleaster, cherry-plum, as well as shrubs: hazelnut, male dogwood, blakthorn, dog rose, under different shares depending on stational conditions. The antierosional forest belts previously established, through their both exceptional functional value and rich biodiversity, represents ecologic, social and economic environmental assets, offering the basics the future action of designing and execution works. Based on obtained results there were prepared appropriate recommendations; toward continuing of establishment of antierosional forest belts under different conditions.*

***Key words:*** *antierosional shelter-belt, soil erosion, agricultural lands.*

## INTRODUCTION

Increasing agricultural areas to the detriment of the forest has made large areas planted to remain completely treeless, thereby causing profound changes in the spectrum of climate and have at result increasing climatic aggressiveness (heavy rains, drought, extreme temperatures) and serious consequences for soil: erosion, landslides in mountainous and hilly; flood, drying pronounced - in the lowlands (meadows, plains). All these processes have negative effects on crop development and of ecosystems biodiversity.

Large areas devoid of forest vegetation were converted into dry land, so farmers and other responsible factors in society were convinced of the need to take urgent measures for ecological restoration.

This measures are necessary to:

a) protecting crops against pests climatic factors (drought, extreme temperatures) as a result of climate change that led in the last 50 years to a climate aridity in Romania, with dramatic accents in southern and eastern regions; such as, after map areas in Romania prone to desertification (Stanescu et al., 1994, quoted by Giurgiu, 2004), the East and the South of the country are the areas most exposed to desertification; land in these areas fall into the category of deserts, semi-arid and dry sub-humid, relationship between precipitation and potential evapotranspiration is much below subunit.

b) preventing and combating soil erosion and landslides as the expression of specific geomorphology, with considerable relief energy; is estimated that in Romania, the water

erosion affects about 47% of the agricultural area of the country, meaning more than 6 million hectares, wind erosion affects 378 hectares and landslides over 700000 ha; out of which, about 2-3 million hectares of agricultural land are strong to excessive degraded, unfit for efficient agriculture, soil losses estimated at 126 million tons (Giurgiu, 2004).

## MATERIALS AND METHODS

The main aspects regarding of the species used in the composition of shelter-belts and their behavior, resulting from observations and research carried out recently in the antierosional shelterbelts installed in the period 1950 - 1980.
Observations on the behaviour and evolution of the forest plantation and of the species used to make forest belts, in relation to environmental conditions, allowed the establishment / improving of afforestation compositions for installing antierosional shelter-belts

## RESULTS AND DISCUSSIONS

### *1. Measures and actions to prevent and control soil erosion*

To prevent degradation by erosion processes (and slides) of land is needed urgent protection measures and works of soil and for stopping soil erosion processes are necessary measures and ecological reconstruction works (afforestation) of these lands.
The complex soil erosion protection is achieved through planning projects and antierosional development of sloping land and watersheds with different uses and include the following measures:
• allocation for agriculture on slopes under climatic conditions and relief orientation of fields in the general direction of the contour ;
• implementation of antierosional agrotechnics, agro working on the general direction of the contour, growing alternative crops in strips with grass strips, crop rotation, antierosion asolment etc;
• establishing a network of channels for evacuating excess water on the slopes and gully erosion;
• establish an optimal network of technological paths, and their location right on the slopes;
• making arrangements phyto-supplying (turning the meadows of the badlands pastures, shelter-belts, agroforestry systems, grassing and afforestation of slopes with inclination greater than 200);
• gully erosion through a proper arrangement;
• stabilizing landslides.
Designing, execution and operation of anti-erosion works in conjunction with the work of the water, hydropower, forestry, roads, according to the interests of landowners and town planning documentation and landscaping, taking into account the protection requirements environment (Moţoc et al., 1975; Munteanu et al., 1991, Law 84/1996).

### *2. Types of antierosional shelter-belts and plantations*

The forest vegetation is a real barrier in soil degradation by rainfall erosion.
A stronger need to implement the results of research on agroforestry planting anti-erosion shelter-belts is emerging in developing sustainable agricultural systems, with their many protective effects of crop agrobiocenotic stability and balance, biodiversity and preventing pollution by pesticides etc. (Malschi et al., 2009).
Antierosional sheter-belts are crops in strips (at least three times) performed on eroded slopes around water reservoirs anti-erosion purposes, on sandy soils to prevent drifting and flood land of the dig-shore waves dams defense and floods (Ciortuz, 2004).
*Antierosional shelter-belts* are bedded on sloping lands along the contour and are designed to turn runoff into underground drain, which is why they are called absorbing belts.
*Shelter-belts for water accumulations protection* are installed around lakes and have the role of strengthening the role of bank, filter rainwater draining the lake, reducing evaporation from the water surface and to beautify the area. The shelter-belts is made up of two bands, namely a reinforcement band (between the mean and maximum water, comprising the hydrophilic species) and a filter band (above the maximum water level, the

width of at least 20 m, having different species composition of deciduous and coniferous) .

*Shelter-belts for sandy lands are bedded* in areas with mobile and semi-mobile sands and are designed to ensure stability, preventing drifting. Such shelter belts form a network of main curtain (in the direction of the prevailing wind perpendicular consisting of 5-7 rows, spaced at a distance equal to the 15 heights of the shafts, respectively to 200-300 m) and the side (perpendicular to the main formats 3-5 rows, spaced at 45 heights, i.e. 500-1000 m apart).

*Shelter-belts for protection of dams* are installed in the dam - shore, 10 m from the foot embankment outside and are designed to protect the dam destructive action of waves and thaw formation. Have variable width of tens or hundreds of meters, consisting of 1-3 bands.

*Agroforestry systems* - are another category of anti-erosion protection systems being practiced little or nothing nowadays. They were rather known by the forester, but now it would be good to be better publicized, as is an opportunity to earn the interest of landowners in rural areas. Ultimately, it is about land use systems in which forest seedlings are planted in combination with crops grown on the same land .

*Forest plantation of protection* - if highly eroded portions of land to the parent rock or even the beginnings of gullies, steep slopes kidnap, ravines and valleys near the bottom of the valleys and ravines as is recommended afforestation drive of the affected areas .

*In the next paragraph we will refer to antierosional shelter-belts.*

### *3. The chracteristics of some antierosional shelter-belts from our country*

The main aspects of the species used in the composition of antierosional shelter-belts and their behavior, resulting from observations and research carried out recently (Constandache et al., 2006), are presented below.

● Antierosional shelter-belts from Perieni (Vaslui - figure 1), land slope to 100, chernozem soil type, moderately to strongly eroded installed before 1950, with a width of 25-30 meters are composed of basic species: greyish oak, acacia; species mix and help: Norway maple, smooth-leaved elm, european sweet cherry, field maple, Tatarian maple (among marginal and apricot); shrub: common hawthorn, dog rose, indigo bush, red dogwood etc.

Figure 1. Antierosional forest-belts at Perieni (photo: Constandache C., Popa N., 2006)

Regarding the behavior of the species were found as follows:

- if the composition of oak mixed with maple, cherry, maple Tatar, maple and shrubs 0.7-0.8 shelter-belt are consistence and active state of vegetation, remarking natural regeneration species composition, oak heights achieved 17 to 18 m and diameters between 28 and 44 cm, other species carried different sizes, rising from the edge inwards (heights of 2-3 m and 4-5 m in the bushes Tatar maple, maple, Prunus cerasifera outward up to 12-16 m in maple and cherry inside the curtain, so the shelter-belt structure is one of the most effective;
- if the locust composition, consistency shelter-belt is lower (0.6-0.7), being quite active

vegetation (dry locust affected due to the age of 60 years) being carried regeneration works, dimensions made locust are pretty good inside the curtain (height 19-20 m , diameter 30-36 cm) and decreases towards the edges (up to heights of 8-10 m) in composition appears maple, but out of natural regeneration (locust was probably installed after thinning, with height of approx. 3 m) and shrubs (dogwood , hawthorn, privet), providing good anti-erosion efficiency.

● Network antierosional shelter-belts of Cean-Boldut of SCDA Turda (Cluj County – figure 2), installed in the years 1950 to 1952 is located in a typical area of low hills of the Transylvanian Plain. It occupies 14 hectares in an area of 342 hectares of farmland and meadows affected by different degradation processes: erosion, landslides, colluvium (Malschi et al., 2009). Relief is slightly troubled, with altitudes between 280 and 460 m and a moderate slope from northeast to southeast. Some portions are steep or vertical fractures or slipping (at the top of the slope).

The shelter-belts are composed of over 36 tree and shrub species (Malschi et al., 2009), among which: greyish oak, ash, cherry, field elm, Siberian elm, lime tree, mahaleb cherry, etc, on land slope of 12-15$^0$ affected by erosion and landslides medium - deep shift in bulk soil type chernozem, or black pine, mahaleb cherry and shrubs (privet, European bladdernut, hawthorn) detachment surfaces, slopes of ravine with slopes greater (Untaru, 1975).

Following recent observations (2006) carried out some of these shelter-belts, it was found to be composed of 5-7 rows placed at distances of 1-1.5 m (to the side) and 2-2.5 m (inside) and the distance between shelter-belts is 200-250 m tree species were usually placed in the middle of the shelter-belts. The shelter-belts analysis at the age of 50-55 has the following characteristics:

- if the target species is within the shelter-belts ash (three times), and the composition is 0.6-0.7 active growing state, the average height of the ash is from 14 to 15 m and the average diameter 20 cm;


Figure 2. The location of shelter-belts network in Cean-Boldut farm of SCDA Turda

- the shelter-belts with the core (3-5 lines) consists of oak mixed with maple, maple and shrubs (dogwood, elderberry, hawthorn) the consistency is 0.8-0.9, the growing state is very active, the oak heights achieved 12 to 15 m in the upper part of the shelter-belts 16 to 18 m, and the slope at the bottom and the shaft diameter between 20 and 30 cm;

- marginal - lines made of cherry plum, hair, common hawthorn, hazelnut, red dogwood, colutea arborescens have very active vegetation condition ensuring proper density .

Research conducted by agronomists showed that ,,the protective forest agroecosystem at Cean-Boldut is a model of green technology for pest control and sustainable development of cereal crops in the hills of central Transylvania" (Malschi et al., 2009).

● Observations made in antierosional shelter-belts from Balta Alba (around the lake), under steppe chernozem soil type influenced by humidity and salt content in Balta Alba, revealed that species gave good results was white poplar, ash from Pennsylvania and oleaster (last marginal rows). In higher areas, and shelter-belt with the composition acacia (middle shelter-belts), cherry plum and oleaster (among marginal) has good vegetation. The shelter-belts has a variable width (from 10 m to 20 m), highest field slope greater than 100, and is located 20-30 m from the lake.

● The helter-belts for the protection of dams analyzed in the dam-bank of the River Prut, having particular composition of poplar and willow species, although it felt following

changes in the hydrological regime of the soil as a result of engineering hydrology of the last time, exerted a significant role in defending premises dams, dykes and banks protection , under exceptional floods in recent years.
The antierosional forest belts analyzed, shows generally good condition and have a role in the dissipation of surface leakage, increase soil water infiltration, reducing soil erosion and stabilization of areas affected by landslides.
Antierosional forests belts previously installed, through their exceptional functional value and the richness and diversity of flora, are of special importance to environmental, social and economic, providing the basics needed for future action planning and execution of these works.

### *4. Technological aspects regarding installation of antierosional shelter-belts*

The layout of the antierosional shelter-belts, width, composition and implementation schemes were the subject of concern for a large number of researchers.

### *4.1. Location of antierosional shelter-belts*

Placing antierosional shelter-belts is such that parcels bounded by them to have a ground and a uniform slope and length as required to obtain maximum yield of agricultural machines .
In previous work (Lupe 1953) recommended that short slopes up to 200 m to 300 m in the forest steppe and steppe, to sit two shelter-belts, one ridge or shelf edge and one at the bottom of the slope. The long slopes, with a slope uniform, except for the bars is recommended to install a number of intermediate shelter-belts, depending on the length of the slope, the inclination thereof by the exposure to wind and the degree of erosion. The undulated terrain with slopes with variable slope, position and width curtains will be determined by the transverse profile of the land.
The distance between the shelter-belts is typically 15-20 times the height of trees, and in the more exposed to erosion of up to 100-150 m distance between the shelter-belts can be determined in relation to erosion and critical distance ranges, usually between 50 and 100 m (Ciortuz, 2004). Following other authors minimum distance between the shelter-belts located on arable land (12% slope) is 300 m and between those located in meadows, 200 m, depending on the degree of erosion landform to (Popa et al., 2005) .
Width of shelter-belts can be calculated using the equation (Ciortuz , 2004):

$$b = \frac{d*k*i}{y-i} \ (m),$$

where “b” is the distance between the shelter-belts, in meters; “k” - coefficient calculation drain the rain, and - computing the intensity of rain, in mm / min, “y”- the intensity of the water absorption by the ground, in mm / min.
Normally, there are adopted widths of 20 to 40 m, reaching 60 m in heavily eroded slopes and 10-14 m on slopes less eroded (Lupe, 1953; Ciortuz, Pacurar, 2004), recommended that if the calculation results in an unacceptably large width, to use a width of 20 m, provided on condition where between rows of seedlings to be made for water retention ditches wave.

### *4.2. Species, afforestation compositions*

Regarding the composition of antierosional forest belts, the authors previously conducted research recommends using the results obtained in our country, based on the recommendations of experiments and less foreign literature often contradictory and do not correspond to our stationary conditions (Catrina, 2005; Lupe, 1953).
Research on the behavior and evolution of culture protection forest on degraded land (Traci, 1985; Untaru, 2005) as well as the latest on the species used to make forest belts against environmental conditions (Constandache et al., 2006, 2007, 2012, 2013) allowed the establishment of afforestation compositions for installing the anti-erosion forest belts as follows.
*Afforestation compositions based on oak tree species, namely*: i) grayish oak (St.b) in the lowlands forest steppe on chernozem/faeoziom soils type ii) common oaks (St) and sessile oak (Go) (in wetter areas) in areas of low hills, lowland forest on chernozem, faeoziom, luvosol, eutricambosoil type soils and fertile aluviosol without salts.

Afforestation composition is: 30 St.b (St.p, Go) 10 Pa.c, Ul 20 Ar.t (Cd, Ul.t, Ju, Mr) 40 Sg (Mc, Sa, Co, Pd).
The osage-orange (Mr), cherry plum (Cd), dog rose (Mc), common hawthorn (Pd) tree species will be placed on marginal lines.
*Afforestation composition based on locust (Sc)*, in forest steppe zones (steppe), low hills, on light soils (chernozems, psamosoil etc.) with low carbon content and *composition with honey locust (Gl)*, in the same areas, on carbonated soils (kastanoziom soil type or chernozems/ faeziom), and other heavy soils. Afforestation composition: 60 Sc (Gl ) 20 Ar.t (Ul. T, Mr, Cd, Ml, Sl, Pr, Dd ) 20 a (Pd, Po, Lc, Mc, etc.);
The locust and honey locust will be placed on interior lines and other species on marginal lines.
*Afforestation composition based on field elm (Ul)* (on calcareous chernozem, alluvisols) or Siberian elm (Ul.T) (on poor or heavy soils, with carbonates and salts) of forest steppe and forest plain. Afforestation composition is 30-50 Ul (Ul.T ) 30 Ju, Ar.t, Mj, Vi.t , Pr, Cd, Mr, Sl 20 – 40 a (Pd, Po, Lc, Mc, Sp, Sâ, Ct.r).
The oleaster (Sl), osage-orange (Mr) and dog rose (Mc) will introduce only marginal lines and among other species, predominantly among interior shelter-belt.
*Afforestation compositions based on common ash (Fr) or Pennsylvania ash (Fr.p)*, in meadows of the forest and forest steppe, on soils with excess water (alluvisols, or hidrisoils class):
40Fr (Fr.p ) 40 Ci, Pr, Cd, Vi.t, Mr, Ar.t 20 a.
The ash tree will be used on fertile soils. The osage-orange and dog rose will introduce only marginal and among other species, predominantly among interior .
*Compositions based on Siberian elm (Ul.T), Chinese poplar (Populus simony – Pl.s) or oleaster (Sl)* on alluvisols or other salty soils: 40Ul.T (Pl.s, Sl ) 20Ar.t (Cd, Pa.c) 40 a (Po, Ct.r).
If the shelter-belt are not exposed to grazing in their composition, a particular economic interest presents the introduction of fruit species such as walnut, cherry wood, apple and pear tree, cherry, blak cherry, cherry-plum, apricot, horn, hazel, hawthorn, red courrant bush, wild rose, blackthorn which to capitalize, may be placed on rows marginal of shelter-belts. Also included are species such as acacia honey, lime-tree, oleaster etc.
The significance of other forestry species symbol is: Te-lime tree, Pa.c. - Norway maple, Ar.t-Tartarian maple, Ju – field maple; Vi.t - mahaleb cherry, Pr-wild pear, a – shrubs.

### *5. The efficiency of antierosional shelter-belts*

The efficiency of shelter-belts is recognized in the fight against drought and other climate related adversities storms, blizzards (Constandache, et al., 2013), in order to prevent and combat soil degradation processes (erosion, landslides), and for land protection biodiversity conservation, landscape.
Protecting soil and crops, shelter-belts have a decisive role in ensuring environmental effects and socio-economic.

***a) The functional effects (ecologic) protection of natural resources and the environment in general, namely:***
- reducing or maintaining the erosion to an acceptable value;
- reduce the loss of water and nutrients, reducing the speed of surface drainage;
- maintaining and improving the productive capacity of the soil;
- enhancement of biodiversity (habitat provide shelter for many species of flora and fauna) and reducing.

The study in arable land protected against erosion mainly by using a contour strip-cropping system and two forest belts (Perieni-Bârlad) in a period of approx. 50 years, show that the forest belts contributed to additional reduction of soil loss with values representing from 8 to 14% of the net erosion. Also, monitoring soil moisture dynamics over a period of 10 years along a cross-section through the entire basin, it was revealed the contribution of shelter-belts in mitigating effects of drought in dry years. Thus, in the area protected by the forest belts, in years when the sum of rainfalls was lower by 20-30% than the multiannual average which is 492mm, the soil water reserve in the 0 to100 cm layer was up to 14% for peas and up to 22% for winter wheat higher than those from surrounding unprotected areas (Popa et al., 2011).

Also, the positive effect of shelter-belts consist in crop protection against pests. The abundance and activity of entomophagous populations were higher in cultures of protective forest system, existing since 1952, the farm Cean-Boldut a S.C.D.A. Turda, where a natural biological control of major pests was registered. By comparison, cereal agroecosystems out in the open, it was necessary to apply insecticide treatments as developing pest populations exceeded the capacity limitation of entomophagous arthropod fauna (Malschi et al., 2009).

Monitoring of wastewater and sludge storage areas of wastewater treatment, show the risks that may affect the quality of surface waters (Panaitescu, Onutu, 2013), especially by discharge in the rivers or lakes. Antierosional shelter-belts may be very useful in such situations, having an important role in reducing runoff, filtration / retention of silts or nutrients from the water/assurance of needed quantity and quality and drinking water, but in camouflage storage areas or sludge treatment plants.

***b) Social and economic effects:***

-can provide the necessary heating of the heat in the hot days of summer, both for people working in agriculture and domestic animals, etc;

-can provide small, but not negligible amounts of firewood and small rural construction through forest exploitation at the end of life cycles (exploitability), which can be quite short, for 20 to 30 years (the locust) .

## CONCLUSIONS

Soil conservation programs have no radical methods or universal recipes. Thus, soil conservation action should not act as one, but only after an plurifactorial analysis and wisely use of all means available to modern hydrology, agricultural and forestry equipment.

In the various categories of works for conservation and soil erosion control, antierosional shelter-belts have a significant role in reducing the leakage superficial slopes.

Organizing judicious planning, using the practice of agrotechnical anti-erosion, must be linked organically, the antierosional shelter-belts representing a basic link in the purview of this complex work.

Anti-erosion measures and work with biological character must be based on thorough research of vegetation to establish assortment of species that meet the conditions in the selected area.

Antierosional shelter-belts must be judiciously designed, requiring a harmonious combination with other measures and agro works to obtain maximum ameliorative effects.

Forest species that need to be given greater attention in the future to be included in the composition of protective erosion are: oak, Norway maple, ash, walnut, European sweet cherry, Siberian elm, field maple, Tartarian maple, honey locust, osage-orange, cherry plum, apricot, and among shrubs: hazelnut, cornel-tree, blackthorn, pigeon, wild rose.

In our country, although performed extensive work was perforemd in order to combat water and wind erosion, to the extent of these phenomena, lately reactivated, we consider that the resumption and continuation of these actions as necessary.

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