Project SURE - Restoration of road embankments with different seed mixtures and application techniques on five sites across Europe

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Abstract

Within the Workpackage 2 of the CADSES Interreg IIIB project SURE, five trials were established in order to evaluate revegetation strategies on road embankments.

Commercial and site-specific seed mixtures (composed by local species of each participating country) and different application techniques were compared in order to assess their effectiveness in the establishment of a sustainable vegetation and in the protection of slopes against erosion.

The main results after two years are shown.

Main target of the trials

The main goal of the trials established within the Workpackage 2 of the CADSES Interreg IIIB project SURE was to put strategies into practice to restore or rehabilitate slopes, e.g. road embankments, after infrastructural interventions.

Commercial and site-specific seed mixtures (composed by local species of each participating country) and different application techniques were compared in order to assess their effectiveness in the establishment of a sustainable vegetation and in the protection of slopes against erosion.

Aiming at a sustainable and ecological sound rehabilitation, actions should increase the quality of areas devastated from infrastructural works, leading to low maintenance costs (e.g. reduced cuttings and fertilization) and increasing the safety of people living in the surroundings.

Description of trials

Table 1: **Main features of the five sites**

State	Location	Elevation (m a.s.l.)	Exposition	Inclination	Application techniques	Seed mixtures (sowing rate g m^{-2})
Italy	SS 464 "Cimpello-Sequals" 30 km NE of Pordenone N46°8'6" E12°49'53"	182-186	W	34°	• conventional hydroseeding • thickness hydroseeding • hydroseeding with bonded fiber matrix	commercial (30 g m^{-2}) site-specific (30 g m^{-2})
Austria	10 km N of Klagenfurt N 46°43'53' E 14°22'49"	470	WSW	45°	• no top soil, black-green system with straw • 5 cm top soil, hydroseeding • 10 cm top soil, hydroseeding	commercial (15 g m^{-2}) site-specific (10 g m^{-2})
Czech Republic	High speed road near Otrokovice Zlin, South East Moravia	184	SW	35°-40°	• hand sowing machine	2 commercial (21 g m^{-2}) site-specific (22 g m^{-2})
Slovakia	Zvolen, Central Slovakia N48°34' E19°05'	349-357	SW	38°-42°	• hand sowing • hydroseed + straw + fertilizer	commercial (15 g m^{-2}) 2 site-specific (15 g m^{-2})
Greece	Province of Polykastro Central Macedonia N 40°59'32" E 22°34'9"	58		> 12°	• conventional sowing by hand • conventional hydroseeding + cellulose + fertilizer • hydroseeding + cellulose + fertilizer + organic geotextile	commercial (25 g m^{-2}) site-specific (25 g m^{-2})

Results and discussion

Italy (trial set up October 2004)

Two drought periods in spring 2005 and summer 2006 seriously limited vegetation growth and caused drying of the above-ground biomass, in particular of sown grasses (litter).

Mean vegetation cover in plots with site-specific seed mixture was always higher (even if not satisfactory) than in plots with commercial seed mixture (respectively 16.9% and 13.9% in June 2006).

In plots with site-specific seed mixture, vegetation cover reached 49.1% including litter (32.2%), while in plots with commercial seed mixture it stayed below 30%.

After 2 years, cover values are not satisfactory due to the extreme site conditions of these road embankments (steep slopes, frequent droughts, etc.)

Nevertheless, the erosion control seems to succeed probably for the development of an acceptable root system (further study is necessary on this topic) and for the pre-

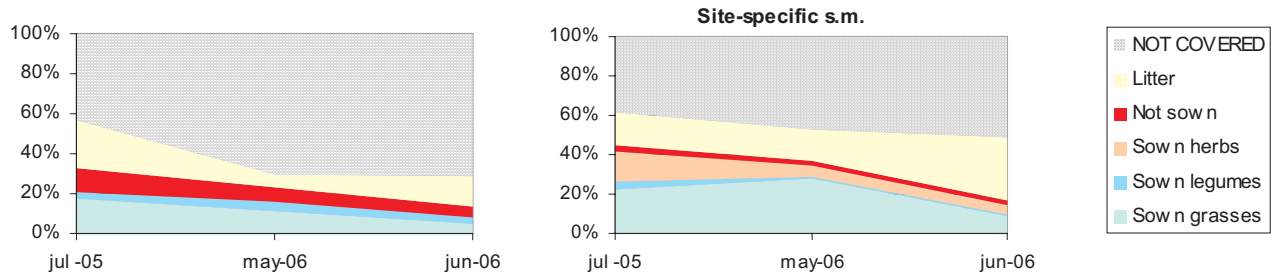

Figure 1: **Mean vegetation cover by seed mixtures in the Italian site**

sence of a noticeable litter cover, which helps preventing soil erosion caused by rain drops.

The revegetated area, in particular plots with commercial seed mixture, is interested by a spontaneous recolonisation, mainly by species of the surrounding dry grassland.

The application techniques did not show any significant effect on vegetation cover, being mean values lower than 43% after the last assessment (including dried above-ground biomass).

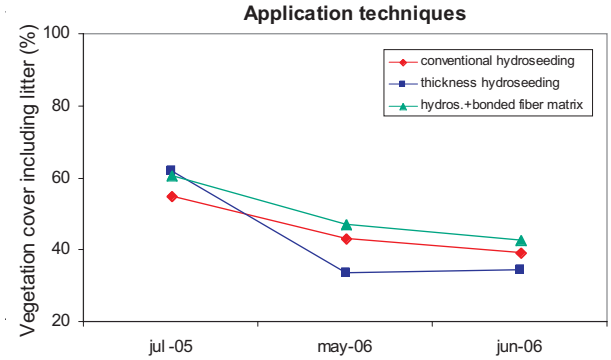

Figure 2: **Mean vegetation cover by application techniques in the Italian site**

Figure 3: **The Italian site one week after sowing and on the second vegetation period**

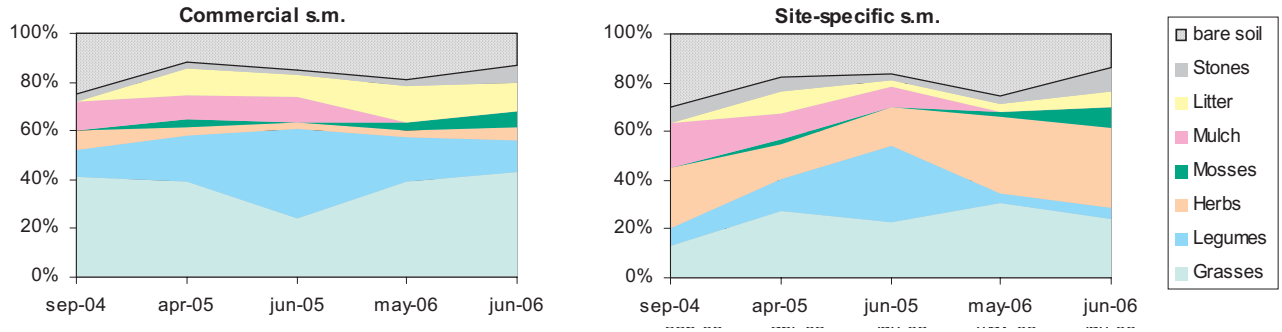

Figure 4: **Mean vegetation cover by seed mixtures in the Austrian site**

Austria (trial set up July 2004)

Mean vegetation cover of the two seed mixtures were similar in the middle of the second vegetation period, reaching 62%. In plots with commercial seed mixture (90% in weight of grasses, mainly *Festuca rubra* and *Lolium perenne*), grasses cover stayed around 40%, except in summer 2005 when legumes cover increased. In plots with site-specific seed mixture the vegetation cover was shared mainly between grasses and herbs (24% and 33% respectively in June 2006), the last given by sown species. At the beginning of the second vegetation period, mulching material (straw) in plots treated with black-green system was completely decomposed.

Among application techniques, hydroseeding on 10 cm of topsoil was the most effective maintaining vegetation cover over 72% in June 2006.

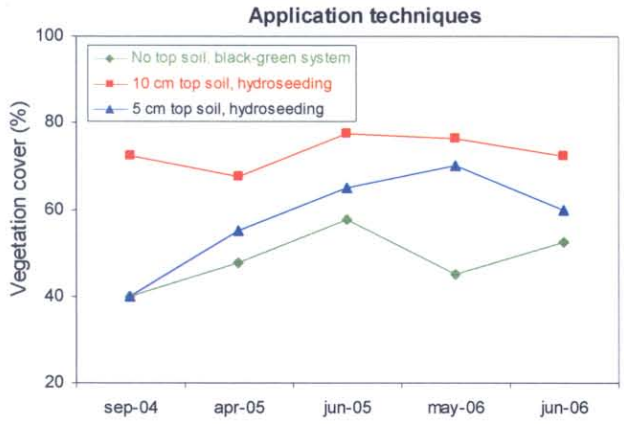

Figure 5: **Mean vegetation cover by application techniques in the Austrian site**

Czech Republic (trial set up June 2005)

Two different grass-mixtures composed by commercial varieties of *Lolium perenne*, *Festuca rubra*, *Poa pratensis* and *Agrostis tenuis* and one mixture composed by *Festuca ovina*, *Festuca rubra* and Czech ecotypes of *Lolium perenne* and *Bromus erectus* were compared.

Total vegetation cover resulted satisfactory in the plot with site-specific seed mixture (85% in July 2006), where sown grasses showed an increasing trend from the trial establishment, in particular the Czech ecotypes. In this plot, vacant spots were partly occupied by spontaneous and ruderal species (14%).

Commercial seed mixtures behave differently. Commercial s.m.1 (same percentage of *Lolium* and *Festuca*

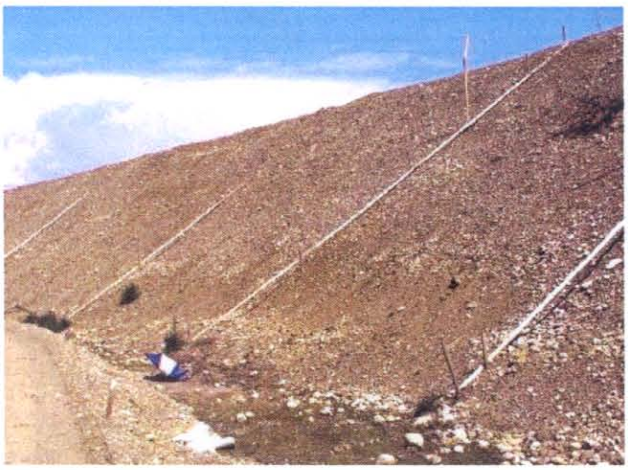

Figure 6: **The Austrian site before sowing and on the second vegetation period**

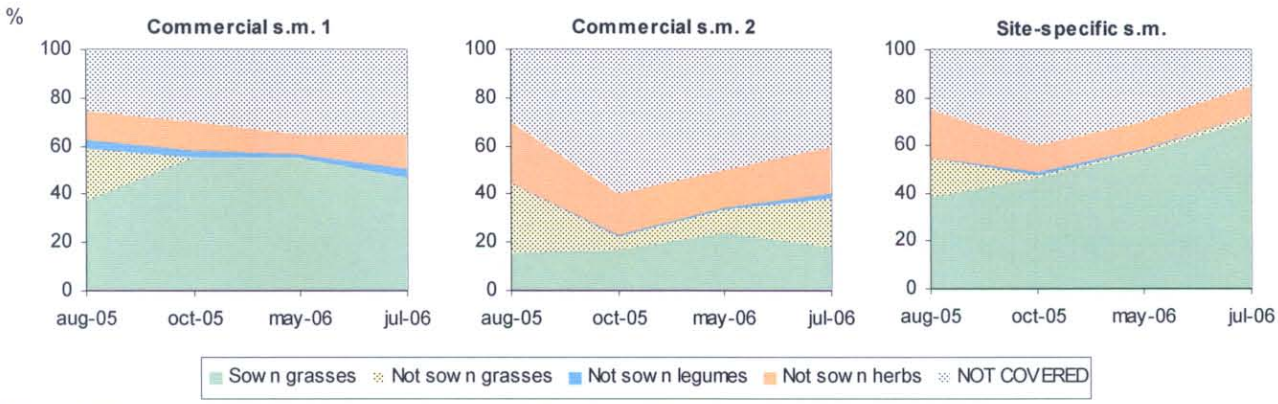

Figure 7: **Mean vegetation cover by seed mixtures in the Czech site**

in the mixture) showed a good total cover (65%) given mainly by sown grasses. In the plot with commercial s.m. 2, *Festuca rubra* varieties (70% in weight in the mixture) scarcely developed and their cover stayed under 20%. Not sown herbs showed a quite constant cover from the first vegetation period (20%).The presence of a noticeable percentage of *Lolium perenne* (18%) was probably due to a dissemination from the adjacent plots.

Slovakia (trial set up October 2004)

The first evaluation after sowing in 2004 showed a good germination of almost all species. In particular, the development of seedlings was more prompt in plots sown with the hydroseeding technique with straw and fertilizer than in plots sown by hand. It seems that straw was a quite supporting element in the year of establishment, but its residues made bare spots later during the growing season. In 2005 assessment of botanical composition confirmed the better spring development of GMARI (Slovakian) site-specific seed mixture and commercial mixture than the Austrian one. Grasses (81-92%) were dominant in GMARI mixture and legumes (20-40%) in commercial mixture. Commercial mixture

Figure 8: **The Czech site during sowing and on the first vegetation period**

Figure 9: **The Slovakian site one month and one year after sowing**

developed in the spring very well because of high percentage of *Lolium perenne* and *Trifolium repens*; moreover, this portion of the road embankment is in the shade of the nearby forest and thus it is a more humid site.

Spontaneous grasses (*Anthoxanthum odoratum*, *Phleum pratense*) were found in the swards; Secale cereale was found as a consequence of the presence of seeds in the applied straw. Dominant legumes were *Trifolium repens* and *Trifolium arvense*. In Austrian site-specific mixture, only *Trifolium pratense* (5%) was found in 2005 although it had not been sown.

In summer 2006, many herbs (14% to 20%) developed in all mixtures, particularly in the lower and more humid part of the road slope.

Greece (trial set up March 2005)

The revegetated area showed good cover values for both seed mixtures (86.7% for commercial s.m., 88.3% for site-specific s.m.). Nevertheless, the most cover was given by spontaneous species and weeds entering from the surrounding (about 20 species), in particular during the dry period from July till the end of September. The spread of weeds and not sown species increased in the second vegetative period.

Among sown species, grasses and legumes neither of commercial s.m. (50% and 24% in weight respectively) nor those of site-specific s.m. (29% and 45% in weight) showed a noticeable development. Only *Phacelia tanacetifolia* (in both seed mixtures) and *Sanguisorba minor* (in site specific s.m.) contributed to cover the area during "rainy" months (total annual rainfall varies from 115 to 345 mm year^{-1}).

The application techniques did not show any significant effect on vegetation cover, the last showing the same trend.

Conclusions

After two years of observations, it is confirmed the importance of the choice of strategies of revegetation in order to obtain satisfactory results both functional (prevention of erosion, low maintenance costs) and qualitative (ecological value, long-term sustainability).

Results of these trials were heavily influenced by site conditions (soil slope, climate, etc.) and by the way of construction of the infrastructure (new road embankment or modification of a pre-existing slope).

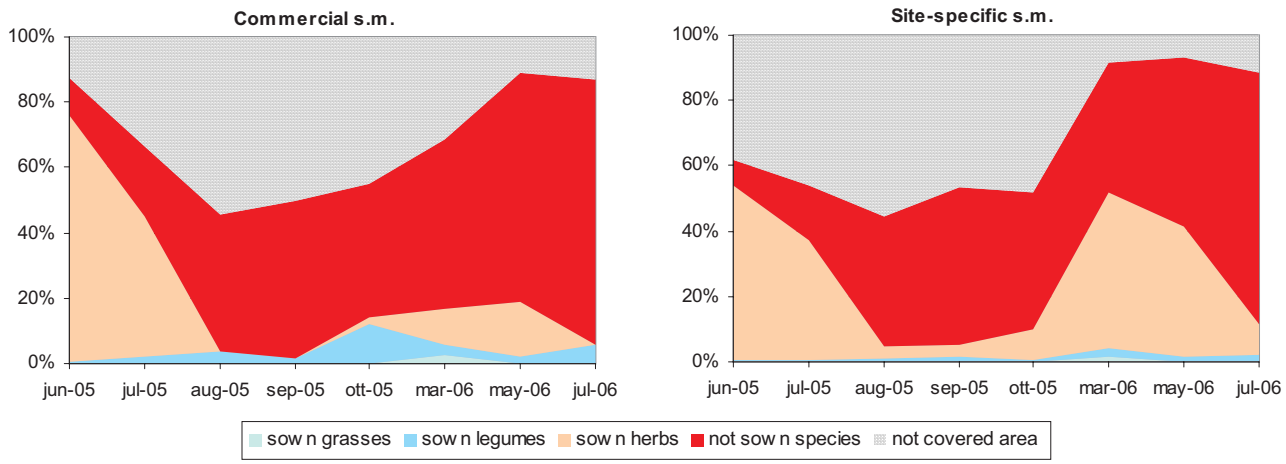

Figure 10: **Mean vegetation cover by seed mixtures in the Greek site**

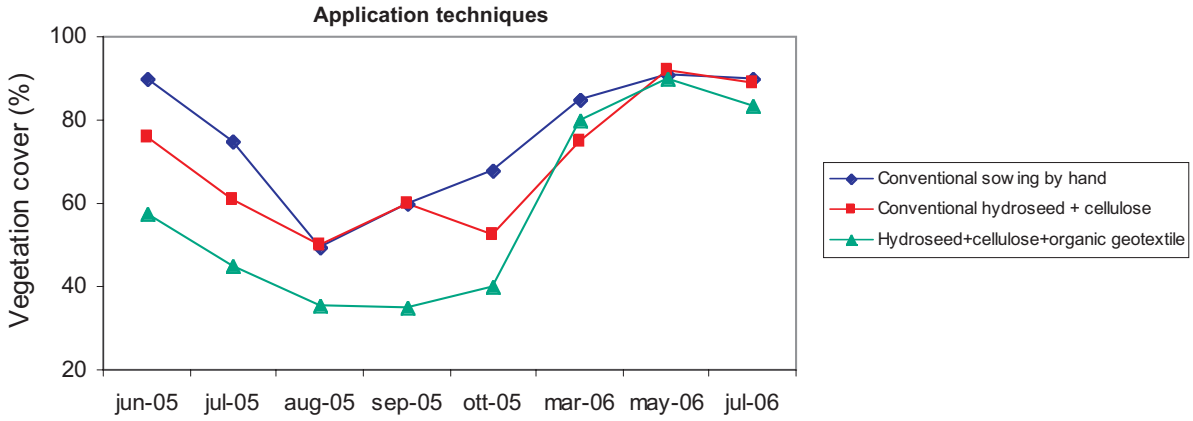

Figure 11: **Mean vegetation cover by application techniques in the Greek site**

Figure 12: **The Greek site one month after sowing and on the first vegetation period**

The performances of site-specific seed mixtures were equal or even better than those of commercial mixtures, in particular in Austria, Czech Republic and Italy.

The awareness of the need for seed mixtures with species selected from the local flora, suitable for the site conditions of the area to be restored, has been achieved. The application of a mulch layer (bonded fiber matrix, straw) or of a topsoil layer, combined with hydroseeding technique, showed to be useful for supporting vegetation cover and thus soil loss prevention.

Acknowledgements

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