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Direct Seeding of Woody Plants as an Alternative to Traditional Plantations

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Introduction

There is a very real need for afforestation in areas degraded by large-scale infrastructure works or environmental cleanup operations, but this differs from the traditional uses of forestry. The timber profitability aspect is not the primary objective. However, the creation of biomass for the development of wood energy is not to be overlooked. The implementation cost has to be attractive, and the value this type of afforestation adds to the environment and landscape is a central consideration. It is in this context – the reforestation of degraded areas – that a research program has been in operation since 2001, within the framework of the management of railways' green dependencies. Réseau Ferrée de France has financed this research program with a view to developing alternative plantation techniques that use less inputs than traditional techniques. Direct seeding is one of the three axes constituting this research and development program (the two others concern biodegradable mulches and seed traps as hedge structures without plantation).

<u>The aim of research on and development of the direct seeding of woody plants:</u>
Monospecific woody plant seeding is known and used unevenly across France as a function of the different afforestation policies of individual departments. The seedings are done with seeds not presenting homogeneous dormancy properties (mainly oak, walnut, sweet chestnut). The materials used are predominantly agricultural, and weed vegetation is removed either mechanically or chemically. Technical and scientific data relating to the direct seeding of mixed woody plants is rare. Therefore, the aims of this research were as follows:

- Define dormancy breaking conditions of seeds by species.
- Define the best seeding methods in terms of cost and implementation difficulty
- Evaluate the influence of seeding techniques on the growth and development of seedings.
- Define the best seeding period by species.
- Evaluate the influence of growth medium on the growth and development of seedings
- Define the quantities of seeds to be sown by species (as a function of seeding techniques) to reach a goal of 10 000 plantlets per hectare in the first year, tending in the long term towards three distinct types of ecosystem: low shrubbery, high shrubbery and oak.
- Produce a technico-economic assessment of the techniques tested.

Materials and Method

The available technical and scientific literature, as well as data collected on experimental farms (in Montoldre and Nancy, both set up in 2003 as part of this research) made it possible to orient choices before creating a full-scale testing site on 35 hectares east of Paris in 2006. Choices were as follows:

- Number of seeds sown : 500,000 seeds per hectare for an anticipated first year yield of 10,000 plantlets per hectare

- Unprepared seeds used (greater availability and more flexibility in terms of seedtime)
- Seedtime : Spring
- Cover crops used; definition of mixtures:

Species mixture H1	Quantity/ha	Species Mixture H2	Quantity/ha
Agrostemma githago	0.5	*Secale cereale L.*	*23.0*
Avena sativa	15	*Fagopyrum esculentum*	*23.0*
Fagopyrum esculentum	10	*Phacelia tanacetifolia Benth.*	*3.0*
Linum usitatissimum	5	*Lotus corniculatus L.*	*1.5*
Lotus corniculatus	1.5	*Festuca ovina*	*17.0*
Lupinus luteus	2	*Trifolium pratense L*	*1.0*
Malva meluca	2	*Trifolium subterraneum*	*3.0*
Papaver rhoas	0.3	*Sinapsis alba*	*3.0*
Phacelia tanacetifolia	3	**TOTAL**	**74.5**
Raphanus sativus	2		
Secale multicaule	15		
Sinapis alba	4		
Total	**60.3**		

- Choice of woody plant mixtures (endemic, flexible woody plants constituting common shrubby and oak ecosystems)

Mixture L1 small seeds:	Dose/ha in kg	No. seeds /Kg	No. seeds /ha
ACER CAMPESTRE	0.700 kg	12,000	8,400
AMELANCHIER OVALIS	0.700 kg	200,000	140,000
CARPINUS BETULUS	2.400 kg	21,500	51,600
CORNUS MAS	3.500 kg	4,600	16,100
CORNUS SANGUINEA	0.700 kg	17,000	11,900
FRAXINUS EXCELSIOR	0.800 kg	15,000	12,000
HIPPOPHAE RHAMNOIDES	0.200 kg	110,000	22,000
MALUS SYLVESTRIS	0.400 kg	28,000	11,200
PRUNUS AVIUM	1.200 kg	6,000	7,200
PRUNUS MAHALEB	0.300 kg	13,000	3,900
PRUNUS SPINOSA	0.700 kg	4,900	3,430
PYRUS COMMUNIS	0.220 kg	35,000	7,700
RHAMNUS CATHARTICA	0.600 kg	60,000	36,000
ROSA CANINA	0.200 kg	50,000	10,000
SAMBUCUS NIGRA	0.200 kg	300,000	60,000
SORBUS ARIA	0.250 kg	50,000	12,500
VIBURNUM LANTANA	2.700 kg	32,000	86,400
TOTAL	**15.770 kg**	**959,000**	500

Mixture L2 large seeds:	Dose/ha in kg	No. seeds /Kg	No. seeds /ha
CORYLUS AVELLANA	7.100 kg	400	2,840
QUERCUS PETRAEA	55.000 kg	245	13,475
TOTAL	**62.100 kg**	**645**	**16,315**

Mixture L3	Dose/ha in kg	No. seeds /Kg	No. seeds /ha
ACER CAMPESTRE	0.350 kg	12,000	4,200
CARPINUS BETULUS	1.200 kg	21,500	25,800
BETULA PENDULA	0.210 kg	2,000,000	420,000
CORNUS SANGUINEA	0.350 kg	17,000	5,950
FRAXINUS EXCELSIOR	0.400 kg	15,000	6,000
MALUS SYLVESTRIS	0.200 kg	28,000	5,600
PRUNUS AVIUM	0.600 kg	6,000	3,600
PRUNUS MAHALEB	0.150 kg	13,000	1,950
SAMBUCUS NIGRA	0.100 kg	300,000	30,000
SORBUS ARIA	0.125 kg	50,000	6,250
TOTAL	**3.685 kg**	**2,462,500**	**509,350**

Mixture L5 on embankment	Dose/ha in kg	No. seeds /Kg	No. seeds /ha
AMELANCHIER OVALIS	0.700 kg	200,000	140,000
CORNUS MAS	1.000 kg	4,600	4,600
CORNUS SANGUINEA	1.700 kg	17,000	28,900
HIPPOPHAE RHAMNOIDES	0.300 kg	110,000	33,000
LABURNUM ANAGYROÏDES	1.600 kg	34,000	54,400
PRUNUS MAHALEB	1.500 kg	13,000	19,500
PRUNUS SPINOSA	1.500 kg	4,900	7,350
RHAMNUS CATHARTICA	1.500 kg	60,000	90,000
ROSA CANINA	0.500 kg	50,000	25,000

VIBURNUM LANTANA	2.000 kg	32,000	64,000
TOTAL	**12.300 kg**	**525,500**	**466,750**

Full-scale testing on 35 hectares of disused railway land east of Paris

Three main tests were conducted:
The different methods were divided into 120 experimental plots measuring approximately 800 m^2.
Test 1 : Comparison of agricultural seeding techniques and hydraulic seeding techniques. With and without accompanying controlled herbaceous vegetation. Two seeding densities were tested corresponding to mixtures L1 and L3. The methods were repeated in 3 complete blocks.
Test 2 : Woody plant seeding with a hydroseeder on an embankment, consisting of 4 repetitions in blocks corresponding to the four directions East/West/South/North on reworked soil, superficial vegetable soil (10 cm). 5 methods of seeding Mixture L5: with controlled herbaceous vegetation, on bare soil, with herbaceous mixture H2, on biodegradable felt, on wood fibre.
Test 3 : Woody plant seeding with mulch, without herbaceous accompaniment. Hydraulic or agricultural seeding techniques. Two thicknesses of mulch tested with two seeding densities.
Type of mulch tested (with two thicknesses: 2 or 6 cm):
Coconut shavings – Hemp straw – Flax straw – Wood fibre – 12/25 gravel – compost

Results and discussion

In spite of the difficulty of implementing protocols – related to the significant influence of the structure, which made it difficult to control work carried out by companies, as well as predation by numerous rodents, birds, deer and especially rabbits – the result of 15,000 plants per hectare was confirmed on the third year of monitoring. The best results were obtained on the mulches, which where the most expensive techniques to implement, though they were still less costly than traditional plantations. These techniques seem to offer a promising avenue; whichever mulch is used, results are better than on bare soil. The accompanying herbaceous cover, which was moderately successful, remains more favourable to woody plants than seeding on bare soil. Among the different seeding techniques, those enabling seeds to be buried are more favourable. In fact, plots seeded using agricultural techniques yield more woody plants. As for weather and scheduling issues, it was not possible to work on all experimental plots simultaneously, and two types of preparation were carried out prior to the seedings for Test 1 (fine or coarse tilling of the soil). Effects on the expression of herbaceous flora were observed. Additional tests would enable these observations to be taken further.

The experimental plots on the Claye-Souilly site present more or less controlled varieties of fallow land. They evolve over the course of the seasons and offer another approach to implementing afforestation, based on taking account of vegetation succession dynamics. It is a whole aesthetic that might not yet meet planners' and residents' expectations, but responds to real ecological and biological issues, at a much lower cost than traditional plantations. These techniques need neither inputs nor maintenance after implementation. Woody plant seedings take more time before they are recognised as afforestation, but they can have interesting landscape results and militate in favour of biodiversity. The use of this type of technique is clearly relevant to the restoration of areas disturbed by anthropic activity as well as to the hundreds of hectares of disused railway land; but it is also of particular interest to regions anxious to regain spaces that appear natural while using durable techniques. The potentialities of these techniques for the production of energy wood are clear; the potentialities for timber still need to be studied. Each year of additional monitoring will bring results likely to enable these techniques to be developed.