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Frédérique Santi, Fulvio Ducci

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Developing new varieties for forestry species used in agroforestry lines

F Santi*, F Ducci**, *UR 588, INRA Val de Loire, **CRA-SEL Arezzo

Context: no improved varieties for most tree species

In European modern agroforestry (hedges or intra field lines), the density of plantation is very low, allowing few future thinning. Moreover, for most of the tree or bushy species, the plants are grown from seeds collected in forests, without the slightest level of improvement. To increase the future production of wood and the benefits of the farmers, the genetic quality of cropped trees should be improved.

Solutions

Short-term solutions include:

- ▶ increase the plantation density: plant 2 to 3 trees instead of only one and remove the worse quickly ;
- ▶ use the plants of the best category of each nursery bed, and therefore encourage nurseries to create elite categories, i.e. the 5% best, and to point them as “designed for agroforestry” in their catalogue.

A medium-term solution is to develop better varieties for numerous bushy and tree marginal species. The amount of work and money is too high with classical tree breeding, therefore we propose to create low-cost seed orchards, with two steps of selection (inside nurseries then inside the putative seed orchard) through participative breeding (method implying deep participation of professional actors).



1st step: intensive selection of elite young plants in private nurseries

Previous studies have shown that as long as the sowing is not dense, the best young plants from nurseries will most generally remain the best at the end.

Participative breeding including most private nurseries draws to very intensive selection: the explored genetic base gathers almost all grown plants. Though, the actual selection rate depends on the number of plants grown in all the nurseries (1/100 to 1/10 000), and should be higher for very young plants (1 year old) than for older ones. To later test if this selection was efficient, controls (medium-size plants) are designed in the same nursery bed, and co-planted with the elite plants in the putative seed orchard in 4-elite-4-control-plants rows, example (final number of trees 8x6=48):

Plantation / selection in:	Plantation / selection in:						Seed zone	
	2014	2015	2014	2015	2016	2016	1	2
2014	○○○○○○○○○○	○○○○○○○○○○	○○○○○○○○○○	○○○○○○○○○○	△△△△△△△△	△△△△△△△△	○	
2015	△△△△△△△△	○○○○○○○○○○	○○○○○○○○○○	△△△△△△△△	△△△△△△△△	○○○○○○○○○○	○	△△
2016	○○○○○○○○○○	△△△△△△△△	○○○○○○○○○○	○○○○○○○○○○	△△△△△△△△	○○○○○○○○○○		△△
2016	△△△△△△△△	○○○○○○○○○○	○○○○○○○○○○	○○○○○○○○○○	○○○○○○○○○○	○○○○○○○○○○		△△
2016	△△△△△△△△	○○○○○○○○○○	○○○○○○○○○○	○○○○○○○○○○	○○○○○○○○○○	○○○○○○○○○○		△△
2016	△△△△△△△△	○○○○○○○○○○	○○○○○○○○○○	○○○○○○○○○○	○○○○○○○○○○	○○○○○○○○○○		△△

2^d step: selection of about 1/4 among the elite plants

- ▶ After several years, measures of growth and form allow the comparison between the elite and the control trees, and between the 1/4 bests (filled forms in the example above) among the elite trees.
- ▶ Putative seed orchards will finally be accredited after demonstrating that elite trees are at least +10% better than control trees, and/or that the ¼ bests are at least +5% better than other elite trees.

Ways to reduce risks

- ▶ Enhanced selection pressure and reduced inbreeding risks by combining in each seed orchard plants selected in all volunteer nurseries and during at least three growing seasons.
- ▶ 2 or 3 putative seed orchards per bushy or tree species are planted so that at least one remains in case some selections fail. No grafting is realized and simple but intensive sylviculture is applied so that unaccredited orchards can remain simple productive plantations.

Plantation of first simple putative seed orchards in France

- ▶ 11 priority species defined by nurseries; first plants selected,
- ▶ sites for the orchards in several nurseries,
- ▶ agreements & technical regulation texts under finalization.

