

IMPROVEMENT OF CULTIVATED PLANTS. SELECTION AIMS AND CRITERIA

A. Gallais & H. Bannerot (editors): Improvement of Cultivated Plants. Selection Aims and Criteria. INRA Publisher, Paris 1992, 768 pages. ISBN 2-7380-0383-4, price FFR 420.

This book is an updated information which has been compiled by more than 90 research scientists of INRA and other related French agricultural research institutions. Each chapter refers to main plant types: cereals, plants producing oil, protein and fodder, vegetables, ornamentals, fruit trees, and forest trees.

The chapter on forest trees gives examples of the breeding strategies and the recent results concerning poplar, wild cherry, maritime pine (*Pinus pinaster*), Douglas fir, larch, and cedar (*Cedrus* sp.) which are representative of the different aspects of the improvement of forest trees in INRA.

It begins with an overview of French forests stressing the diversity of its types, its functions and its management. This diversity leads to the need for improvement a large amount of species. The particularity of forest trees (limited domestication, long generations, important time needed for the expression of certain traits) is first recalled for readers who may often be used to plants with reduced genetic diversity and short breeding cycles.

Poplar (M. VILLAR, F. LEFÈVRE, J. C. LEPLI, C. PICHOT & E. TEISSIER DU CROS)

Historically the first species involved in French poplar breeding were aspens and white poplar and their different hybrids: hybrid aspen and grey poplar. After 1975 emphasis was also put on black and eastern cottonwoods as well as on the Eurasian black poplar. The three latter species are improved according to a recurrent scheme aiming at producing interamerican and euramerican hybrids. Because of vegetative propagation and clonal forestry the most important selection trait is resistance to diseases: bark bacterial canker and leaf fungus diseases. Branching and bole straightness are also of high importance for these species mainly transformed by peeling to produce veneer for vegetable and fruit containers.

Poplars are also involved in biotechnology. One example is gene transfer using *Agrobacterium tumefaciens* as a vector. INRA is currently involved in the transfer of insect resistance genes. One construct includes a proteinase inhibitor. A second one includes genes coding for toxins of *Bacillus thuringiensis*.

Wild cherry (M. LEMOINE, J. DUFOR & F. SANTI)

This high value broadleaf has a scattered habitat. Nevertheless the interpopulation diversity, estimated with alloenzymatic markers, is limited. This may be due to the long distance transport by pollinator insects like bees. The population size estimated by the number of genotypes present in a stand is often reduced due to the natural root suckering ability of the species.

Genetic improvement of this species leads to four types of forest reproductive material: (1) Selected seed stands. (2) Polyclonal varieties. Several dozens of clones originating from phenotypic selection are being tested in a comparative network for adaptation, resistance to the leaf fungus *Blumeriella jaapii*, vigor and branching. (3) Regional progeny seed orchards also representing a means for the conservation of genetic resources. (4) Clonal seed orchards. Because of the strong relationship between values of clones and of their general combining ability, clones for seed orchards are selected in clonal tests.

Maritime pine (*Pinus pinaster*) (P. BARADAT & P. PASTUSZKA)

This species covers 1.5 million hectares in French forests. It produces more than 6 million cubic meters of lumber and industry wood. Its different races belong to three groups which have been discriminated by terpene markers. (1) Atlantic group: Portugal, northwest Spain, southwest France. (2) Mediterranean group: southeast Spain, southeast France, Italy, Corsica and Sardinia. (3) North African group: Morocco, Algeria and Tunisia.

The multigeneration recurrent improvement mostly focuses on the southwest France resource with a selection index including vigor, stem straightness, branching habit and wood basic density. But interest is also paid to resources of the western part of the Iberian peninsula and of northwest Morocco in which resistance to the cochineal *Matsucoccus feytaudi* has been found for the reforestation of devastated stands of southeast France and to the Corsican resource which, when hybridized with the southwest resource, improves bole straightness.

Because of the important amount of stands established by direct row seeding, a large part of the forest reproductive material originates from seed harvested in local felled stands whose autochthonous origin is proven by genetic tests. Improved varieties are produced in progeny seed orchards, clonal seed orchards and polycross (or clone equivalent) seed orchards.

Douglas fir (J.-C. BASTIEN & B. ROMAN-AMAT)

This highly productive exotic tree has been introduced in France in 1827. It is the first reforestation species in France. Optimum sites are found in humid climates in altitudes below 900 m. The rotation which is currently around 60 years will be reduced to 45 years thanks to intensive management and advanced genetic improvement.

The multigeneration improvement strategy was first based on adapted French resources and then on those of western Washington and Oregon. Selection traits include adaptation, vigor, stem form, branching and wood quality.

The forest reproductive material originates from French selected and controlled seed stands and from American seed zones which have proven their superiority in provenance tests. First generation seed orchards include phenotypically selected clones of French artificial stands. Second generation seed orchards include clones selected in provenance tests. The third generation of seed orchards will include clones which have been detected by combined index selection in provenance/progeny tests. Their general combining ability is currently being tested by polycrossed progeny tests.

Larch (L. PÂQUES)

Although larch is a natural species of Alpine zones in France, the best material for reforestation is roughly the same area as Douglas fir and even at lower elevation in western France originates from central Europe. Furthermore, attention is also paid to the hybrid between European larch and Japanese larch which has shown strong signs of vigor, resistance to bark canker (*Lachnellula willkommii*) and plasticity.

The base population of European larch has been collected among stands of Poland, Czech Republic and Wienerwald (Austria). The populations of Japanese larch originate from Hondo (Japan).

The forest reproductive material will essentially originate from seed orchards: clonal seed orchards for European larch and hybrid larch. Green house seed orchards with mechanical pollen collection and pollination are under study for hybrid larch to overcome the non overlapping flowering periods of the two species. In the future, part of the hybrid forest reproductive material is likely to originate from bulk propagated F_1 seedlings, from vegetatively propagated F_1 clones, from somatic embryogenesis of F_1 lines and from F_2 seed of F_1 clonal seed orchards.

Cedars (M. BARITEAU & P. FERRANDES)

Three species out of four belonging to this Genus have a Mediterranean habitat: *Cedrus atlantica* in north Africa, *Ce-*

rus brevifolia in Cyprus island and *Cedrus libani* in Turkey, Syria and Lebanon. The fourth one, *Cedrus deodara*, has developed over a very broad range in the Himalaya. *C. atlantica* has shown its ability to adapt to French Mediterranean regions in which its has cooperated for the reconstitution of degraded ecosystems. Furthermore, *C. libani* of Taurus mountains in Turkey has expressed a higher potential than the previous one to withstand soils originating from limestone parent material.

Seed for reforestation originates from selected seed stands of *C. atlantica* established in different parts of southeast France in the second half of the XIXth Century and also partly from Turkish *C. libani* stands. In the future, seed sources will be diversified thanks to the establishment a new series of *C. libani* provenance and progeny tests.

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