# Accomplishments and challenges of conifer somatic embryogenesis for the implementation of multi-varietal forestry

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## Multi-Varietal Forestry

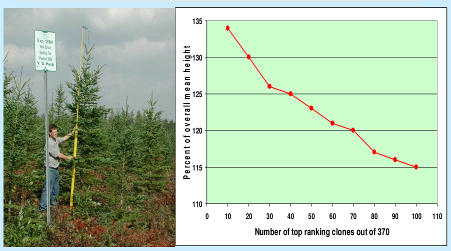
Multi-varietal forestry (MVF) may be defined as the use of genetically tested tree varieties in commercial plantation forestry.

## Advantages of MVF

There are many advantages to MVF, including:

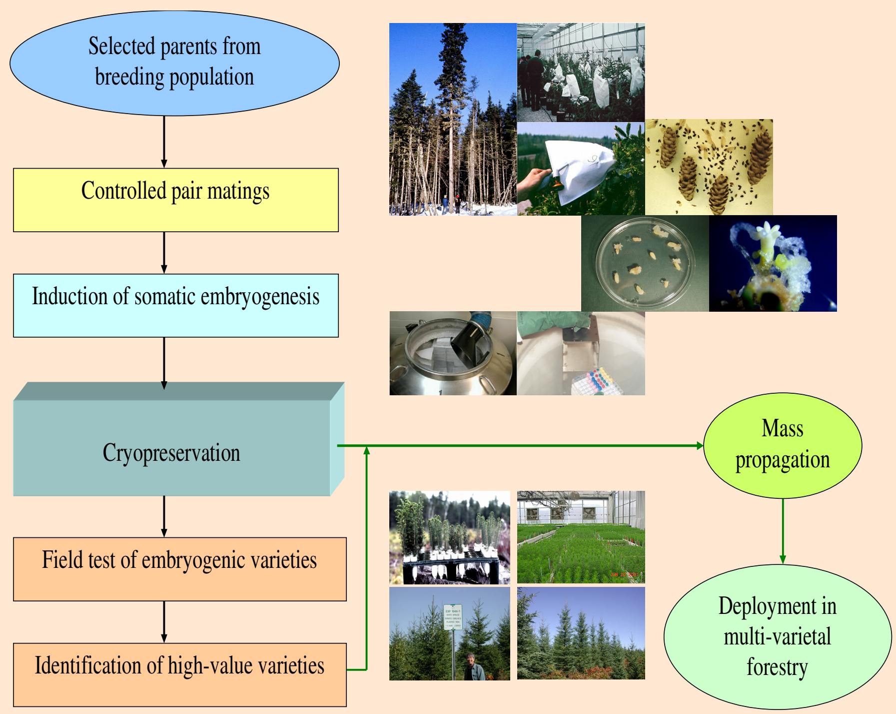
- much greater genetic improvement than is possible through conventional tree breeding techniques;
- suitable varieties can be rapidly introduced to meet changing breeding goals, site conditions, and environment change;
- diversity in plantations can be carefully managed by using appropriate mixtures of tested varieties in time and space.

### Potential genetic gains with MVF




- Clonally replicated genetic test of *P. glauca* evaluated at age 9 for height
- Test included 370 clones from 72 full-sib crosses
- Test planted at 3 locations with 16 ramets per location

## Schematic presentation of implementing MVF using somatic embryogenesis




## Challenges and Accomplishments

Somatic embryogenesis and cryopreservation are the primary enabling technologies for implementing MVF. The implementation of MVF requires four critical steps:

**Step 1. The development of a sufficiently refined SE system** must be achieved, and this is currently available for several conifer species.

Achievements in SE initiation and conversion rates

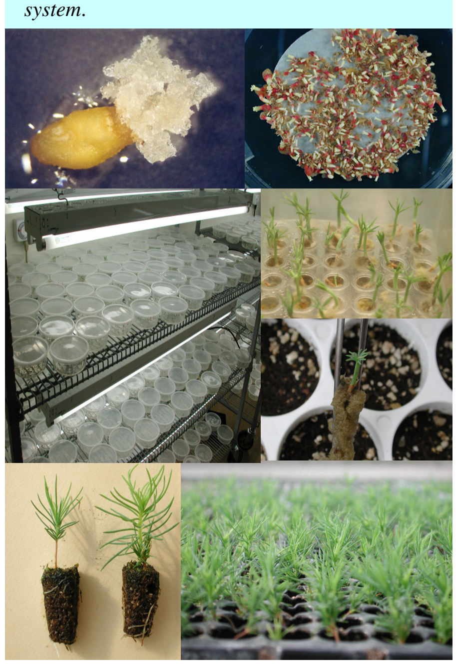
| Species | Immature ZE | Mature ZE | Conversion |
|---|---|---|---|
| *Picea glauca* | 68% | 20% | 89% |
| *P. mariana* | 65% | 21% | 85% |
| *P. abies* | 75% | 29% | 80% |
| *Pinus strobus* | 61% | 2% | 76% |
| *P. monticola* | 6% | 0% | 75% |
| *P. banksiana* | 4% | 0% | 90% |
| *P. taeda* | 36% | 0% | 66% |
| *P. pinaster* | 76% | 0% | 58% |
| *P. sylvestris* | 20% | 0% | 85% |

**Step 2. The development of high-value varietal lines** is required, which involves tree breeding and field testing while maintaining SE lines being tested in cryogenic storage.

### Varietal testing scheme in NB, Canada

- *200-300 varieties from 20-30 elite crosses*
- *3-4 test sites in New Brunswick*
- *12 ramets of each variety are planted per site*
- *Evaluation every 5 years*
- *Currently, over 2,000 lines in the field tests*

**Step 3. Mass vegetative propagation** must be achieved in a cost-effective manner. Artificial seed and an automated embryo handling system are currently being developed, e.g., *micro-plug system*.



**Step 4. Deployment and management of diversity in MVF.** The deployment of embryogenic varieties in plantations requires a careful balancing act to optimize genetic gain yet maintain plantation diversity. Once an appropriate number of varieties has been decided, a deployment strategy must consider the configuration of deployed varieties. Over time, diversity among plantations will also be managed by introducing new clones during each breeding cycle.

### Public perception and issues of MVF

*"The deployment of SE varieties may lead to increased vulnerability to insects and diseases"*

- *For known pests, MVF is better prepared by deploying resistant varieties*
- *For unknown or introduced pests, protection is limited despite the large variability in forest trees; however, the deployment of multi-vaietal mixtures may alleviate the problem*

### Deployment strategies for MVF

- *Mosaic of Monoclonal Mixtures (MOMs)*
- *Widespread Intimately Mixed Plantations (WIMPs)*
- *Mixture of Varieties and Seedlings (MOVAS)*
- *Desired Gain Mixtures – Set a level of genetic gain to maintain a desired level of diversity*
- *Linear Deployment – Greater representation of better-known varieties*
- *Species Mixture*