Biotechnology

Increasing Forest Yield

What is Biotechnology?

Biotechnology is the use of genetic information and biological techniques to create new products and services.

Canada is currently exploring biotechnology as a way to increase forest yield.

Forest Yield: Past to Present

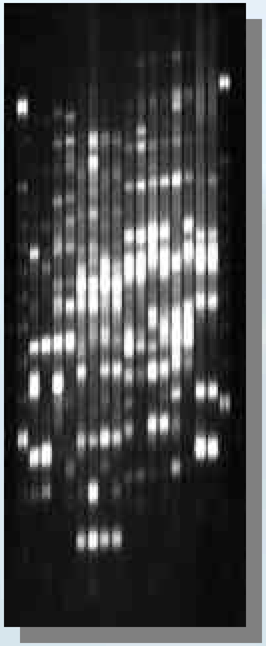
The traditional method of increasing forest yield is to plant more trees. But the waiting time is extensive and the number of trees that fail to mature due to disease, pests or other natural disasters can be high.

With the help of biotechnology, genetically improved trees are the new tool used for boosting forest yield. These trees are created with desirable qualities like faster growth, stress tolerance, and improved wood quality.

Biotechnology and Forest Yield

Using biotechnology, Canadian Forest Service (CFS) scientists are now better able to:

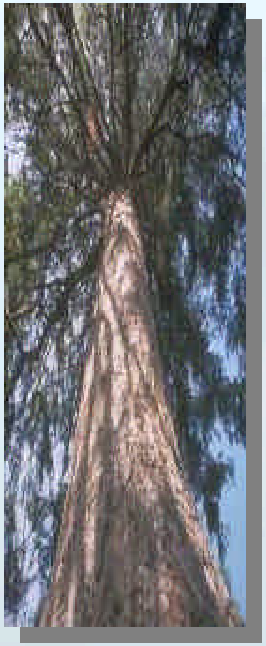
- identify and select trees with superior traits; and
- speed up the reproduction of these “superior” trees.



What Makes a Tree Superior?

CFS scientists are using advanced genetics research – such as molecular markers and genome mapping – to identify trees with special traits. These traits include:

- Faster growth
- Superior wood fibre quality
- Increased resistance to pests, disease or extreme weather conditions



Advanced Genetics

Identifying trees with special traits can be done in the field and further studied in the laboratory. DNA from a superior tree can be taken from its tissue and studied to identify specific markers for a certain trait.

The CFS is currently researching the use of molecular markers as diagnostic, evaluation, early selection and forensic tools. Areas of application include spruce, pine, maple, alien pests and pathogens.

Using Clones

Trees with superior desired traits are identified and reproduced in large quantities through cloning.

Clonal forestry allows for greater genetic gain than conventional tree breeding. It can respond quickly to changes in breeding goals or environment, and makes managing genetic gain and diversity easier.

Somatic Embryogenesis

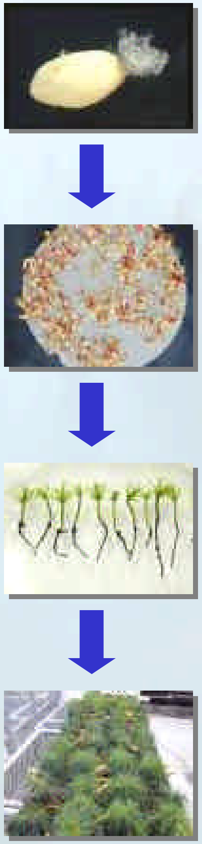
One of the best cloning techniques currently employed by the CFS is somatic embryogenesis (SE), which uses tissue culture to mass produce genetically identical plants.

With almost 20 years of SE experience, the CFS is widely respected as a world leader in this area and continues to be at the forefront of SE research.

How it Works

SE incorporates four steps:

- Initiation of embryogenic tissue
- Maturation of somatic embryos
- Germination of embryos
- Greenhouse culture for planting



Step One: Initiation

SE starts with an immature embryo from the seed of a superior tree. The embryo is put in a Petri dish, containing nutrients and plant growth regulators, and left to grow.

After about six weeks, some of the growing tissue converts to embryogenic tissue. This is the tissue needed to create new trees. The embryogenic tissue can be frozen at this point for later use.

Step Two: Maturation

The embryogenic tissue is removed from the Petri dish and placed in a new environment.

At this stage, the embryogenic tissue stops reproducing and starts evolving into mature somatic embryos. These new embryos look like embryos normally found in seeds.

Step Three: Germination

Once a somatic embryo is fully developed, it is removed from the maturation medium and placed in a germination medium so it can start to develop roots and grow.

At this stage, roots and shoots begin to form much the same way that plants start to grow from seeds.

Step Four: Greenhouse culture

The germinated somatic embryos, or emblings, are then transplanted into a greenhouse.

Growing is continued in a greenhouse and then, emblings are planted in the field.

Advantages of SE

Embryogenic tissue can be stored at –196 °C indefinitely with no adverse effects. After field tests, tissue from the best clones can be thawed out and used to produce more trees.

The most common method of cloning only works with trees up to five years old, but identifying superior trees in the field takes longer than that. SE, on the other hand, is not time sensitive.

Cloning Concerns

Increased vulnerability. Clonal plantation can be vulnerable to disease and pests due to their narrow genetic base. A resistance to known pests can be bred but there is less protection from unknown pests.

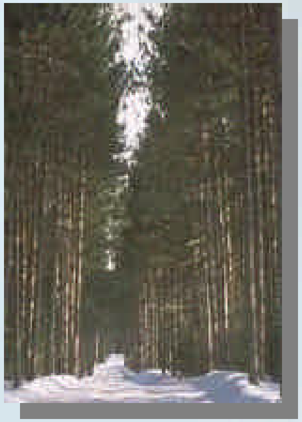
Use of susceptible clones. Susceptible clones could be introduced into a plantation unknowingly. If a greater mix of clones is used, this risk is reduced but so is the genetic gain. Finding an optimal balance is key.

Biotechnology Goals

Using biotechnology to increase forest yields, the CFS and its partners are working to achieve Sustainable forest development.

Increased productivity in commercial forestry will reduce the need to harvest existing natural forests.

- Improved productivity of managed forests will result in a more efficient and abundant source of wood, thereby contributing to maintaining Canada's share of the World's market of wood and wood products.



Contact Information

To learn more about increasing forest yields through biotechnology, contact:

Dr. Ariane Plourde
Research Director- Forest Biology
Canadian Forest Service / Natural Resources Canada
1055 P.E.P.S. Street, P.O. Box 3800
Ste-Foy, G1V 4C7
Telephone: 648-7616(418)
Fax: 648-6956(418)
E-mail: Ariane.Plourde@nrcan.gc.ca

Website:
http://www.nrcan-rncan.gc.ca/cfs-scf/science/resrch/biotechnology_e.html