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Tree Improvement Strategies

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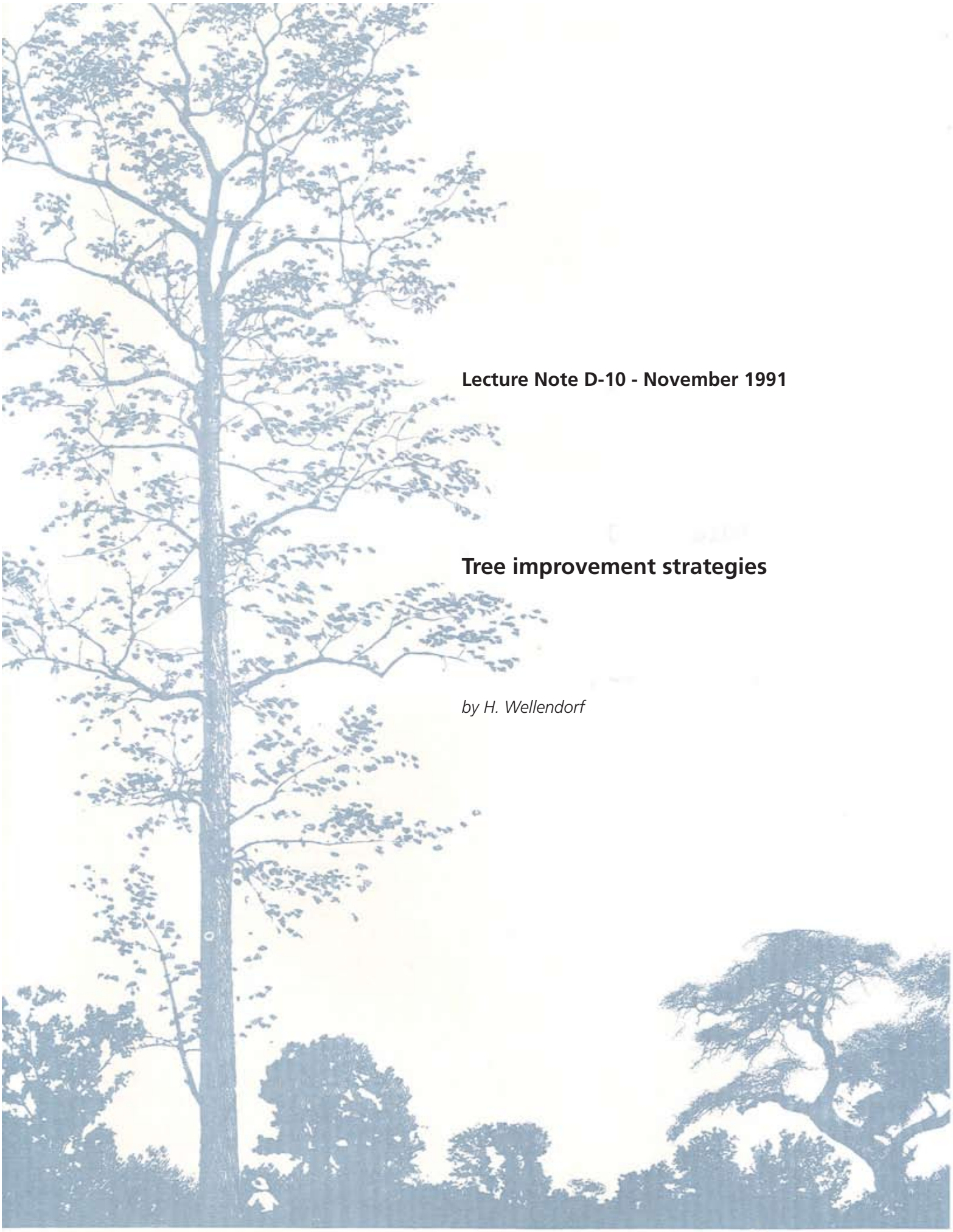
Publication date:
1991

Document version
Publisher's PDF, also known as Version of record

Citation for published version (APA):
Wellendorf, H. (1991). *Tree Improvement Strategies*. Danida Forest Seed Centre. Lecture Note D-10

Download date: 13. Nov. 2026



Lecture Note D-10 - November 1991

Tree improvement strategies

by H. Wellendorf

DANIDA FOREST SEED CENTRE

Titel
Tree Improvement Strategies

Authors
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Publisher
Danida Forest Seed Centre

Series - title and no.
Lecture Note D-10

DTP
Melita Jørgensen

Citation
Wellendorf, H. 1991. Tree improvement strategies. Lecture Note D-10. Danida Forest Seed Centre, Humlebaek, Denmark.

Citation allowed with clear source indication
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1. General Considerations about Tree Improvement Strategy

The somewhat ambitious word »strategy« is used in tree breeding because it reflects certain similarities between planning and execution of wars and planning and execution especially of long term improvement programmes.

One similarity is that you have to plan with available but far from complete knowledge about the true state of nature. In the military sphere this state of nature is your opponent's resources and way of thinking, in our tree improvement it is our incomplete biological knowledge paired with the dynamics of future forestry and genetics.

More specifically, the challenge in tree improvement strategy is to formulate long term plans through many generations, which, nevertheless, are flexible and/or robust enough to incorporate changes in forest policy, silvi-cultural methods as well as innovations in genetics and in propagation methods.

The ambition is to demonstrate simple methods which are relatively easy to manage on a large scale. These methods are, however, based on recent ideas in forest genetics.

A basic aspect is demonstrated by Cotterill (1986) in the following figure.

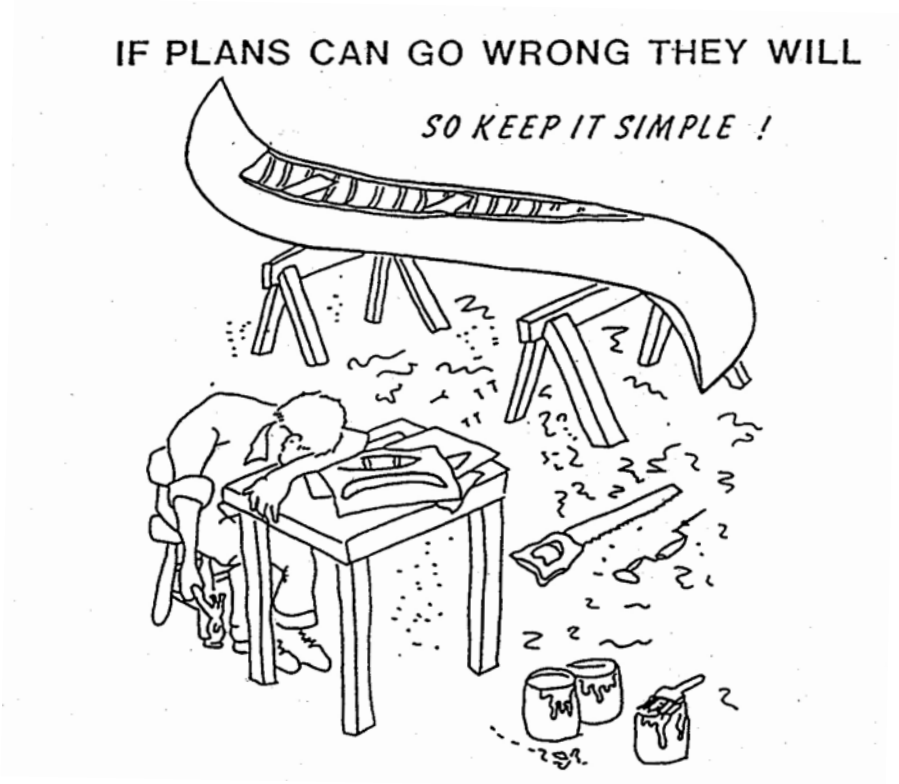


Fig. 1.

2. Initiation of a National Tree Improvement Strategy

A formulated national tree seed programme is a necessary assumption for development of a tree improvement strategy in a given country.

A national tree seed programme includes:

1) Availability of necessary economic resources

2) Availability of a national seed centre supplemented with local sub-stations

3) A quantified seed demand, distributed to:

Species
Plantation zones
A time schedule

(ref. to Lecture notes A-1 and C-1)

The tree improvement strategy involves, much simplified, two steps:

a) Sub-populations (provenances) are allocated to plantation zones and priorities are set for further improvement within these sub-populations (fig. 2).

b) Within these sub-populations, both short term and long term seed sources are identified and/or created.

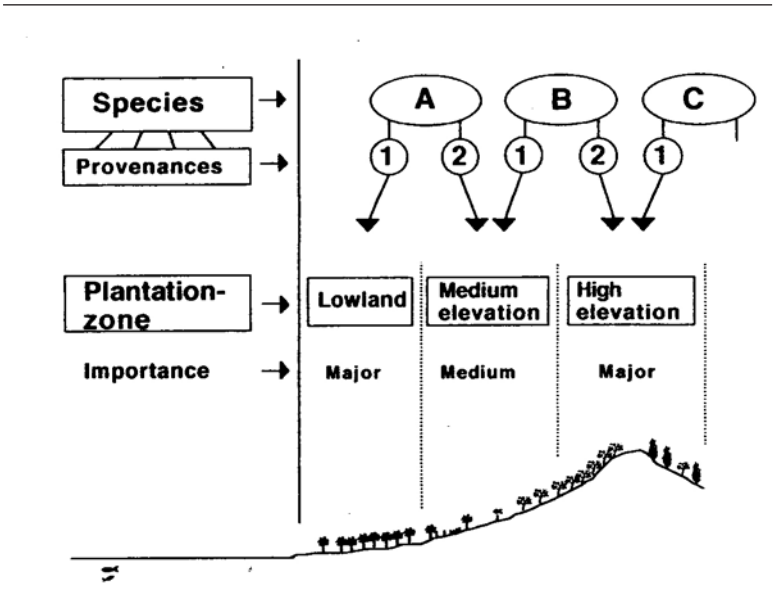
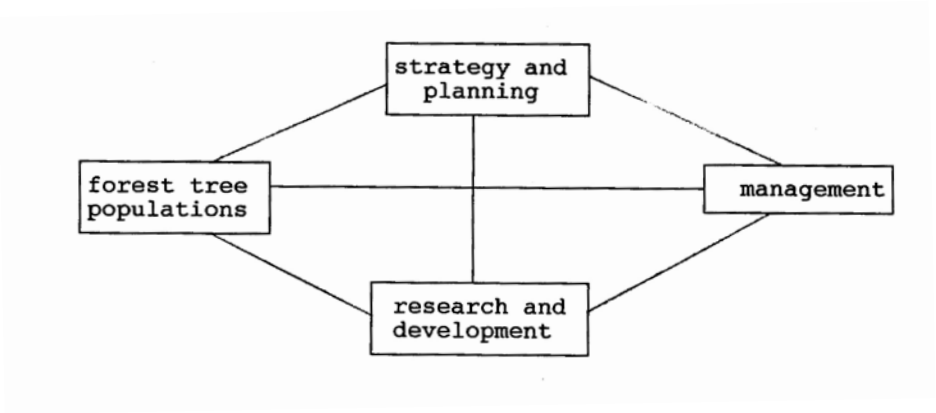


Fig. 2. An example of allocation of sub-populations

3. Main Elements of Tree Improvement



Apart from the strategy three other important elements are indicated on the diagram:

Forest tree populations:	These are the basic resources. Their structure and handling are the core of tree improvement.
Management:	The human and organizational base for tree improvement activities.
Research and development:	Research and development are necessary for solving certain key problems in tree improve ment.

3.1 Management

To be able to carry out any tree improvement programme, an organizational base is required.

This organization must be able to manage the tree improvement activities, both short and long term, and with a sufficient geographic coverage.

A review of important management considerations associated with tree breeding programmes in the tropics is given by Namkoong, Barnes and Burley (1980). The keywords are stability and continuity, personal training and career structure and finally national programmes and international cooperation.

It is self-evident that the chosen strategy should not be more ambitious than the organizational structure is able to handle, both from a short and a long term point of view.

3.2 Research and development

There are certain general and specific problems associated with tree breeding which go beyond the capability of individual programmes.

Development of quantitative-genetical analytical methods for field trials, and development of vegetative propagation methods for a particular tree species are two such examples, which may be developed by a restricted number of agencies and their experience may be used elsewhere.

On the other hand, there are specific areas of research which are desirable to carry out locally. Typical examples are field testing and selection of own plant material in the home environment.

3.3 Tree populations

When allocation of sub-populations (provenances) to plantation zones has been decided, tree improvement at different levels can begin.

Figure 3 shows the concept of multiple population breeding based on the situation in figure 2.

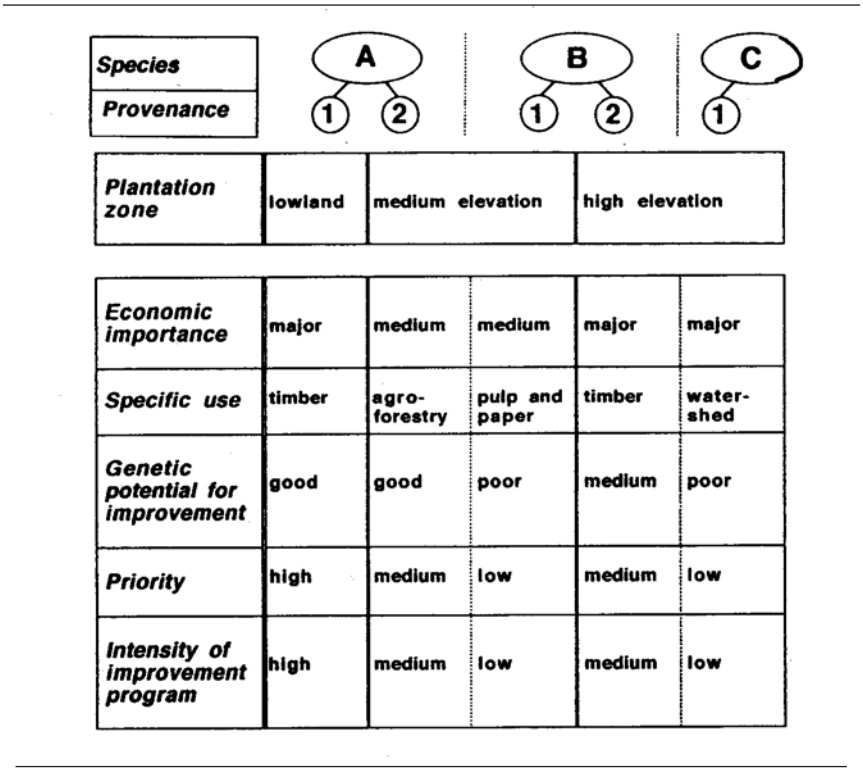


Fig. 3. Multiple population breeding

In each column a matching of a base population to a plantation zone has been made. 5 sub-populations are identified.

Dependent on the priority of these multiple populations, improvement programmes of different intensity can be launched. In any case, we advocate long term improvement programmes, even for low-priority sub-populations. Simple and inexpensive methods may still be long term, for instance simple mass selection in recurrent generations.

Figure 4 shows the functional populations within each column in figure 3.

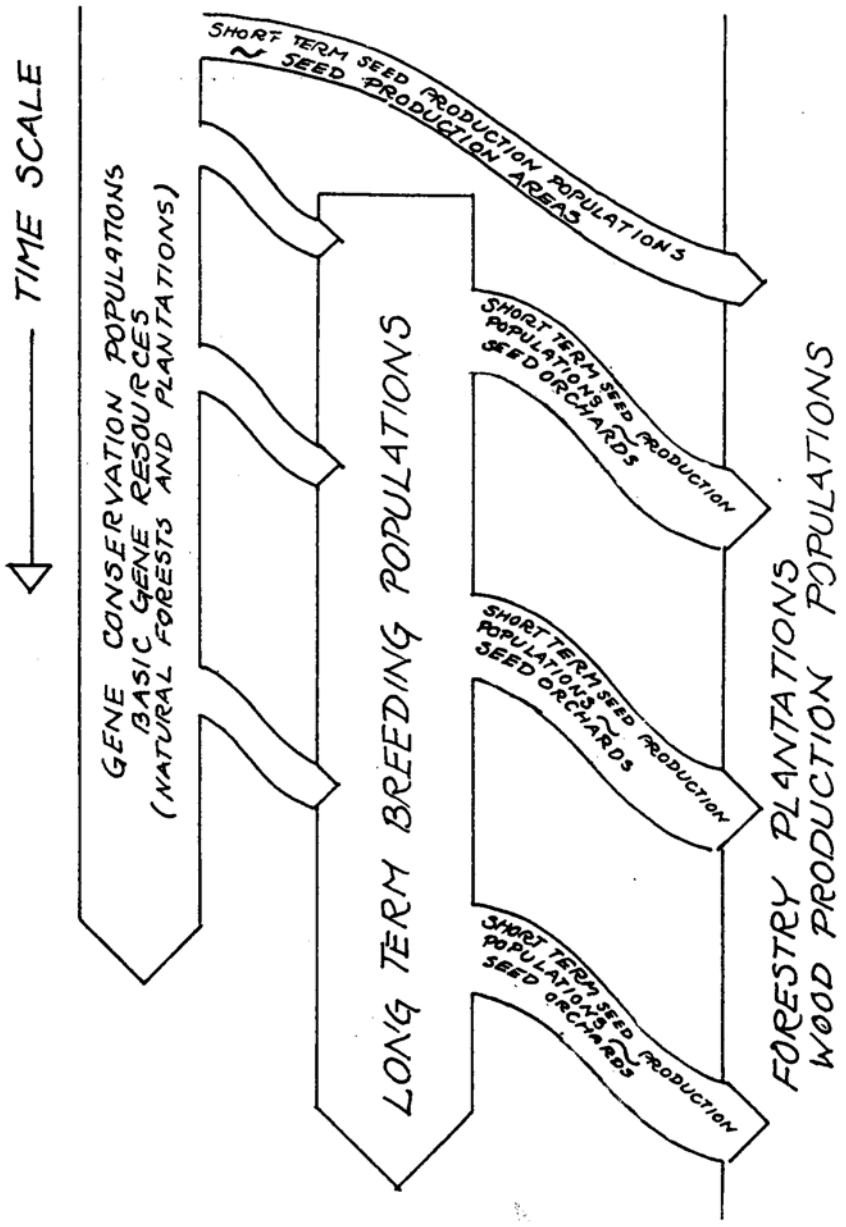


Fig. 4. Functional tree populations in a tree improvement programme

On the left side of figure 4 there is a vertical time scale running from top to bottom.

3.3.1 Gene conservation populations

The populations to the left in figure 4 are base populations for breeding and should be considered as gene conservation populations. These are natural stands and plantations. The important property is that they maintain the undisturbed genetic variation of the wild populations through generations.

The justifications for conserving such populations are:

a) When natural forest disappear, the basic gene resources may vanish too.

b) Access to the original basic gene resources is essential even when you have intensive plantation programmes. Access is particularly important for tree breeding. Otherwise the breeders and the plantation managers may run short of genetic variation and, for instance, disease disasters may develop. These dangers may be more pronounced if clonal forestry is applied on a large scale.

3.3.2 Long term breeding populations

These populations are the core of any long term breeding programme. In contrast to gene conservation populations, selection for desired characters changes the gene frequen-cies. This selection is, however restricted in such a manner that genetic variation is kept approximately on the same level as in the wild populations. That means that even after many generations of improvement, the breeding populations should still be flexible gene resources for further improvement even in possible new directions.

3.3.3 Short term seed production populations

It is from these seed production units that the actual benefits from breeding are transferred to practical forestry. Typically, seed orchards are specifically designed for this purpose. More basic, carefully selected natural stands or plantations may be converted to seed production areas. At the other end of the scale, vegetative propagules may be produced for the same purpose. Further genetic gain through stronger selection for more specified traits may often be realized by these populations. The sacrifice for this further gain is restricted genetic variation in the material delivered to large scale forestry.

The above mentioned distinction between populations is mainly functional.

3.3.4 Examples

In practice, a certain stand may have more than one function:

Example 1: A tract of a natural forest, which has been declared »*in-situ* gene conservation stand« (Lecture note A-4), may have a double function:

1) Long term gene conservation

2) Short term seed production i.e. a stand that mass produces seed in quantities for direct use.

Example 2: A seedling seed orchard (Lecture note B-1 and D-8) may have the following functions:

1) Breeding orchard, i.e. an orchard in which the next generation of the long term breeding population is generated.

2) Short term seed production, i.e. an orchard that mass produces seed in quantities for direct use.

These two examples show that, even with limited resources, long and short term demands can be fulfilled by simple methods.

The important situation to avoid is lack of »robustness«, for instance by heavily relying on a single seed source which may be destroyed or prove to be unreliable. A basic idea in the multiple population concept is never to put all your eggs in one basket, and always learn to think in terms of generations.

4. References

Cotterill, P. 1986

Breeding strategy: Don't underestimate simplicity! Proc. IUFRO Conference on Breeding Theory, Progeny Testing and Seed Orchards. Williamsburg, Virginia, USA. p.8-23.

Namkoong, G., Barnes, R.D. & Burley, J. 1980

A Philosophy of Breeding Strategy for Tropical Forest Trees. - Tropical Forestry Papers, No. 16, Univ. of Oxford. 67pp.

Namkoong, G., Kang, H.C. & Brouard, J.S. 1989

Tree Breeding: Principles and Strategies. Monographs on Theoretical and Applied Genetics II. Springer-Verlag.

Wellendorf, H. & Kaosa-Ard, A. 1988

Teak Improvement Strategy in Thailand. Forest Tree Improvement. Arboretum, Hørsholm, Denmark. Vol. 21, 43pp.

Appendix

Suggested procedures for tree improvement at different levels of intensity

1. Low intensity

1.1. Improvement without individual tree management and without field testing.

Base populations:	Local natural forests Local land races	Representative samples should be conserved as genetic resources
Short term seed supply:	Seed collection zones Identified stands, Selected stands, Seed production areas	No provenance testing required
Long term breeding populations:	The above mentioned stands	
Long term breeding populations in successive generations:	New seed production areas	

1.2. Improvement with bulked mass-selection

As 1.1, but next generation is created repeatedly by bulked offspring from mass selection (100-200 plus trees). These new generations of seed stands are outplanted at replicated sites and preferably isolated from contaminating pollen.

This is a recurrent procedure, which is able to develop local landraces.

2. Medium intensity

2.1. Bulked mass-selection picked in tested provenenaces.

Base populations:	1) Local natural forests 2) Local land races 3) Exotic sources, and 4) Provenance seed stands.	identified through provenance tests
Short term seed supply:	Import from exotic or local sources. Provenance seed stands from say 3 successful origins.	
Long term breeding populations:	Provenance seed stands followed by mass selection (100-200 plus trees) -> bulked offspring into next generation seed stands. Recurrent procedure.	

[1] Refer to Lecture Notes B-1, B-2 and B-3

3. High intensity

3.1. Mass-selection followed up by Seedling Seed Orchards (SSO).

As 2.1 until establishment of long term breeding populations. Open pollinated families from the 100-200 plus trees kept separate and put into SSO. The open pollinated families in the SSO are tested on a number of sites.

Forward selection[2] in the best open pollinated families constitutes the foundation of the next generation SSO. Some restriction on pedigree required to counter too narrow genetic base.

Short term seed supply in later generations from Seed Stands and/or SSO, and/or from Clonal Seed Orchards (CSO-option).

2- Selection in the offspring for the next generation