Can national tree seed programmes generate economic, social and/or environmental benefits to cover their costs?
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Can national tree seed programmes generate economic, social and/or environmental benefits that cover their costs?

Considerations on economics, sustainability and challenges ahead for tree seed centres in tropical countries

Lars Graudal and Erik D. Kjaer
Danida Forest Seed Centre, August 2000 (rev. 8/8)

1. Introduction: can national tree seed centres/programmes in Africa survive?

During the recent decade tree planting has increased in many parts of Africa with focus on trees planted by farmers as part of their land-use. Also, conservation of the genetic resources of trees has emerged as a political priority along with the increased pressure on forest resources taking place in many regions. Establishment and management of national programmes for integrated tree seed supply, tree improvement and gene resource conservation (in short ‘national tree seed programmes’) have therefore become increasingly important.

Tree seed centres have been established in a number of African countries over the last 20 years. Many have in the establishment phase received external support for periods, typically 5-10 years, some longer. Given the recent development just referred to, one would expect these centres to be important focal points in national tree seed programmes in several countries, and therefore also recognised to be of high priority. However, this does certainly not always seem to be the case. Many centres are at present facing serious financial problems, and may in some cases even be considered an economic burden rather than an important asset in the development of tree planting programmes. Symptoms of this ‘crisis’ are lack of funding following insufficient business in sale of seed and services, and lack of investments for maintenance of the non-commercial activities of the centres.

Why is this so? Have the national seed centres not been successful in identifying and solving their tasks? Are they based on wrong assumptions regarding their ability to become financially self-reliant? Have they been based on poorly adapted technology? Have they not been successful in establishment of the required co-operation with and support to all stakeholders in the tree seed sector? Has their institutional set-up not been sufficiently adapted to the local conditions and the changes in planting patterns? Are they evaluated on short term achievements even though their major objectives are long term?

There are probably many and diverse reasons for the ‘crisis’, and the situation will vary from country to country. The purpose of this paper is to identify and discuss some possible reasons in order to look for possible solutions to the ‘crisis’.

A brief introduction to the concepts of sustainability is given in section 2. The functions of tree seed programmes and the scope of financial sustainability normally assumed in the design of such programmes are dealt with in section 3. Possible reasons for the crisis are discussed in section 4. Finally, challenges ahead of tree seed programmes are summarised in section 5.
This account is based on ‘empirical first-hand impressions’ from work with technical support to national tree seed programmes in several countries over approximately 15 years (cf. e.g. Graudal & Thomsen 2000, these proceedings). The description is thus both ‘subjective’ and generalised, i.e. not based on thorough detailed objective analysis of national tree seed programmes. Such analyses are, however, underway (Nathan 2000) and will hopefully provide us with better knowledge and tools to improve the design of tree seed programmes in the future.

2. Sustainability in narrow and broad senses
What is required for a national tree seed centre to be sustainable? Different aspects of sustainability must be considered: financial, technical, institutional, policy support, environmental and national economic. These aspects are connected and often difficult to separate from each other. They are all part of long-term economic sustainability, and each aspect has to be considered.

Financial sustainability
Financial sustainability usually refers to financial self-reliance, implying that the income of the seed producing organisation should balance or exceed expenditure. Basic prerequisites of such financial sustainability are current ability and willingness of the users to pay for seed and services.

Another important aspect of financial sustainability is that the level of investment has to be affordable considering the general macro-economic situation. One should not buy a ‘Rolls Royce’ unless it is required and one can afford to run it.

Technical sustainability
Technical sustainability implies that provision of seed, promotion of good practice, and measures to conserve genetic diversity, are at a level and involve technologies that can be implemented, and further developed, by the seed procurement organisation in liaison with the seed users, and other stakeholders in the sector. The technologies promoted by most tree seed programmes must therefore in general concentrate on the multiplication by seed (well-known and robust system for most species), and where this is not possible, by traditional methods of vegetative propagation.

The balance between implementation of existing technologies and development of new technologies is important. New technologies are often needed in order to improve the propagation and use of local species. However, too much emphasis is often put on research and development, and too little emphasis is put on practical implementation of simple, already known, methods and routines. The research needs should of course be recognised by the national research institutions, universities or agricultural research organisations, and here a national tree seed programme can contribute. The institutional co-operation is very important (cf. also below)

Institutional sustainability
Considering the long time horizon of working with forest genetic resources, it is important to have permanent well-functioning institutions. The implementation of a national tree seed programme will normally have the best chance of success if it is based on existing organisational structures with close relation to users whether small or large, whether public or private.
Analysis of existing ‘institutions’ (in a broad sense) involved in seed supply and tree planting, and the ‘best’ balance between public and private enterprises are important to consider. Although in general best based on existing institutions, new modes of co-operation between these are often highly required. Also, capacity building through training and twinning is often important. Such arrangements can include co-operation between institutions both within and between countries and regions.

The institutional set-up is crucial because a lot of ‘energy’ can materialize when co-operation is well organised; or put differently, so much ‘energy’ can be lost if institutional barriers block for otherwise quite straightforward solutions. But institutional set-up is also an important part of overall sustainability as one cannot expect a seed programme to continue developing over time if the key institutions in the seed network are likely to exist only for a few years. Permanent institutions are required in order to ‘carry’ the tree seed programme.

Policy support

Overall policy support is also important to achieve sustainability. National priority has to be assigned to the area, and the development of specific policies to guide and regulate the use of tree seed is often required. Policy support requires awareness by decision makers. They must realise the important values that can be protected and generated by a specialised and well managed (cf. discussion below) national tree seed programme.

National economic and environmental sustainability

Eventually, all kinds of economic development depend on natural resources. Development based on the use of natural resources will only be sustainable if the resources at the same time are maintained. In the long term, environmental and economic development are thus two sides of the same coin. Sustainable forestry will therefore comprise both (i) continuous production of wood, fodder, food and other products, (ii) maintenance of the environmental protection functions, (iii) conservation of intact ecosystems to safeguard biological diversity and genetic resources, and (iv) the interaction with alternative land uses and their long-term viability.

In this context, it should be realised that tree seed programmes can contribute to present and future income in many ways of which only few will generate direct payments to the seed centre. In a broader perspective, national tree seed programmes should therefore not necessarily be financially self-reliant, but rather obtain funding that reflects their actual contributions to the value of planted trees and environmental sustainability in the short as well as the long run.

3. The functions of tree seed programmes and the scope of sustainability

The role and functions of national tree seed programmes are described in a historical context by Graudal (2000, these proceedings). In the following, we discuss the different aspects of sustainability of these tasks in a general manner (section 3.1), and then we focus in more detail on the commercial aspects, because of their importance as a potential source of revenue to finance the various activities of a tree seed programme (section 3.2).

3.1 The mixture of commercial business and public sector services

All tree plantings should be based on an appropriate genetic foundation (cf. e.g. discussion in Hansen & Kjær, 1999). The basic objective of a tree seed programmes is therefore to secure that good seed is used for tree plantings, today and in the future. The tasks of a tree seed programme may include (i) seed production and supply, (ii) protection and management of...
seed sources and gene conservation stands, (iii) genetic improvement, (iv) training of and advisory services to users, and (v) regulation of movement and use of seed. These tasks will comprise a number of field activities, both in the short, medium and long term:

- **Short term** considerations: supply of good seed to the nurseries ‘here and now’ will include activities such as:
  - identify good seed sources
  - collect, process and sell seed from superior sources
  - develop and improve methods for cost effective seed collection and processing
  - marketing of good seed
  - promote use of the good seed sources and application of good techniques through information
  - set up guidelines for movement of seed between ecologically different regions

- **Medium term** considerations (protecting and improving the genetic quality of the seed sources, and improving techniques for seed handling and application) will often include activities such as:
  - manage and protect identified seed sources
  - develop facilities for seed storage for species where this is required
  - establish improved seed sources, and initiate breeding programmes for high priority species
  - develop and implement formal procedures for seed source registration and documentation on regional or national scale
  - initiate and support research in e.g. seed physiology, storage techniques and vegetative propagation

- **Long term** considerations will include activities required to ensure long term availability of good germplasm for planting purposes. This will include protection and conservation of genetic diversity at all levels. Also, capacity building and demonstration of gains from the use of good seed sources.

A fully developed national tree seed programme is thus many facets including many partners in a network of organisations and institutions. Some activities are usually under the direct responsibility of a national centre, while other activities mainly support other stakeholders. Commercial activities thus typically go hand in hand with public sector services; and short term business goes hand in hand with medium and long term investments.

Some activities generate immediate income to the seed centres (e.g. commercial seed supply). Other activities generate income to the seed centres, but in the longer term (e.g. seed source establishment and management). Some activities generate income to other stakeholders (e.g. distribution of good planting material and extension of good practises to as many users as possible, including support to use of best available seed sources, research and development, guidelines and legislative measurements, and establishment of breeding programmes). Some activities generate benefits, which are difficult to quantify in terms of money (e.g. protection of genetic resources) even when they are important from a socio-economic point of view.

In general terms, all the activities listed above can be grouped into six categories of benefit and activity, depending on the time scope and the beneficiaries (Table 1 and 2).
<table>
<thead>
<tr>
<th>Time scope</th>
<th>Beneficiaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Short term (benefits appear within 1-7 years)</td>
<td>II. Long term (investments, where benefits appear after 7 years or more)</td>
</tr>
<tr>
<td>‘Dealer profit’ A.I.</td>
<td>‘Dealer fortune’ A.II.</td>
</tr>
<tr>
<td>‘Grower profit’ B.I.</td>
<td>‘Grower fortune’ B.II.</td>
</tr>
<tr>
<td>‘Societal profit’ C.I.</td>
<td>‘Societal fortune’ C.II.</td>
</tr>
</tbody>
</table>

Table 2. Example of activities associated with the different categories of benefit from national tree seed programmes (cf. Table 1, above)

<table>
<thead>
<tr>
<th>Type</th>
<th>Benefit</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.I</td>
<td>Seed dealers’ cash profit</td>
<td>Harvest and sale of good seed. Example: a seed programme produces seed or seedlings and sells them to afforestation projects</td>
</tr>
<tr>
<td>A.II</td>
<td>Seed dealers’ fortune</td>
<td>Production of improved seed for future sale. Example: seed programme establishes improved seed sources and sells the seed, if possible at a higher price</td>
</tr>
<tr>
<td>B.I</td>
<td>Tree growers’ cash profit</td>
<td>Supply and use of best available planting stock. Example: a seed programme recommends use of the best available seed sources, and a large number of tree planters gain from growing better trees and reducing the risk of failures</td>
</tr>
<tr>
<td>B.II</td>
<td>Tree growers’ fortune</td>
<td>Supply and use of best available improved planting stock. Example: trees are grown from improved seed sources (established by seed centres, villages, co-operatives or other partners), and a large number of tree planters gain from growing much better trees</td>
</tr>
<tr>
<td>C.I</td>
<td>Societal profit</td>
<td>Extension of good practice to as many users as possible through all relevant institutions of the society. Institutional capacity mobilisation (‘good practice learned today’). Example: a seed programme supports training and capacity building in different organisations working within the tree seed sector (including legislation, improvement and conservation issues)</td>
</tr>
<tr>
<td>C.II</td>
<td>Societal fortune</td>
<td>Safe-guarding future options. Institutional capacity building and conservation of genetic resources (‘knowledge and resources in the future’). Example: a seed programme monitors the conservation status of forest genetic resources and plans, initiates and/or coordinates required activities to support protection and sustainable use as required</td>
</tr>
</tbody>
</table>
Which of these types of activities are ‘economically sustainable’? Obviously, it depends on how economical sustainability is perceived. Economic sustainability is often (in what we here will call the ‘short-term commercial perception’) seen as a question of financial self-reliance (i.e. only financial sustainability as described in section 2 above is then considered). In this perception, only Type A.I and A.II activities (cf. Table 1 and 2) are seen as financially sustainable. Sometimes self-reliance is even required in a short time perspective, which means that only type A.I activities are seen as financially sustainable. However, many of the economic and environmental most important activities are the B.I and B.II types of effort where benefits flow to other stakeholders. Further, some of these activities are in general difficult to handle by the private sector alone, e.g. genetic research as a basis for supply of improved planting stock, which increases the need for public sector support.

These B-type activities are like roads: everybody wants to use them, but few would like (or can afford) to pay them. Still, many roads (albeit not all) should be built, because they support economic growth and release huge benefits of many kinds. Type B activities of national seed programmes are the equivalent infrastructure for tree plantings. Benefits from tree plantings will be increased by well functioning seed programmes, because best, and continuously better, seed is made available for the tree planters at present and over the years. Type B activities do generate benefits, but the benefits do not return as income to a national tree seed centre.

Often, it is possible to come up with a rough estimate of how much income are generated from a given type B activity, and such estimates are useful in the prioritisation process. However, it will normally require a more detailed analysis to determine more specifically who gains, and how it influences the overall economy e.g. through multiplicator effects.

For some activities it is altogether difficult to quantify the gains in economic terms (Type C in table 1 and 2). Such activities typically require direct public (national, regional or local) support, because only limited incentives exist for private sector involvement. Such type C activities can be crucial for use of good seed sources in the long run (i.e. any kind of sustainability), and must therefore be included in the national seed programmes. But they will not generate any direct income that can finance the activities of the investor.

In practice, there may be some overlap between the categories in Table 1 and 2. Single individuals cannot afford to set-up breeding programmes, but co-operatives/villages may sometimes be able to make this kind of investment. Actually, some of the worlds most effective breeding programmes for industrial tree species have been organised by private or semi-private enterprises, alone or in joint consortiums. These consortiums breed the trees in order to improve their plantations for their production of pulp or timber, not to sell the seed. In such cases, the investors also harvest the benefit. Still, others could benefit from getting access to the improved planting stock, and a public co-ordinated effort would thus generate benefits to more people. Another example of overlap is where donor-financed rural development projects are able to pay the national tree seed centre money for training courses to local people (i.e. there is so to speak ‘a market for training and extension’). This income can then contribute to the financing of the national seed programme, at least within a (short) period of time.
3.2 The consequences of a ‘short-term commercial perception’

Looking at the list of potential activities to be included in national seed programmes, it becomes obvious that a ‘short-term commercial perception’ of financial sustainability most likely will lead to programmes that focus solely on A.I type of activities (Table 2). These activities may actually be the least important (compared to A.II, and especially B and C activities). The role of the private sector will be most obvious in exactly these type of activities. Government involvement is more required for all the other activities. The potential benefits from such important type A.II, B and C activities may therefore be lost if a ‘short-term commercial perception’ is applied. These aspects will be discussed in more details below.

The species and their commercial potential

It is usually assumed that tree seed supply for important plantation species has the potential of becoming a commercial, financially sustainable activity in the medium term (5-10 years), i.e. type A.I (cf. Table 1 and 2). This assumption is basic to the ‘short-term commercial perception’ of achieving financial self-reliance. Prerequisites are, as mentioned in section 2 above, awareness among seed users of the benefits that may be achieved from using better seeds, and ability and willingness of seed users to pay for such seeds. These conditions are, however, only seldom fulfilled. Furthermore, other important short term functions such as promoting use of good techniques and development of guidelines for wise movement of seed (cf. above), can hardly be expected to be financed by revenues from seed sale, and therefore constitute activities of B.I type. These advisory functions may easily have more impact on the use of good seed than the actual seed trade, but in the ‘short-term commercial perception’ they are not economically sustainable.

Some species are planted for environmental protection purposes or in a subsistence economy. These species are important (otherwise they would not be planted). However, the short-term possibility of financing use of better seed is here less, because the trees do not generate products that are sold on the market. In the ‘short-term commercial perception’, these species are thus not suitable for sustainable business.

Some species possess the possibility to produce very valuable products in the form of precious timber. Such species are at present mostly harvested in natural forests, but in the not to distant future, production may have to rely on plantation forestry. Such species require investments in conservation now. In the long term this will most likely be good business. High value hardwood timber of indigenous species is a commodity which seems to be running out all over the world. The lost options from doing nothing may be dramatic. In the ‘short-term commercial perception’ such species are not suitable for seed business, because uncertain investments have to be made now, whereas the expected income will be years ahead.

Rich or poor clients: the customers and their ability to pay

The role of the tree seed centre as a service institution entails that it should respond to the needs of the different customers on the market, whether actual or potential. The customers of tree seed centres can often be roughly divided in the following two groups (Graudal 2000, these proceedings):

- farmers and communities in rural areas using and planting trees for a multitude of purposes and
- more organised enterprises or agencies, or private investors often undertaking afforestation on a larger scale, in general for industrial purposes.
The latter group will typically have the ability to pay for the seed and their priorities in terms of species are usually fairly well-known. For the former group, a certain degree of self-sufficiency in supply of plants is likely to be an important way to achieve sustainability. Often their priorities are not very well known by the tree seed programmes and will have to be identified when setting priorities. The extension of improved practices to this group can usually not be financed by the planters themselves, but is an important public responsibility to be included in national tree seed programmes. In the ‘short-term commercial perception’ such activities are not financially sustainable.

Financial self-reliance or economic sustainability of national seed programmes?
Based on the above considerations we claim that the ‘short-term commercial perception’ of economic sustainability is not appropriate when evaluating national seed programmes. The overall national economic and environmental interest in a national tree seed centre lies in its contribution to improved production and environmental rehabilitation, which cannot rely on the revenue that can be generated from seed sale alone. Many elements of a national tree seed programme (such as the extension of knowledge on good practise to the users; research and development in seed collection-storage-use, genetic improvement of seed sources, and conservation of genetic resources) are of national importance, best solved in networks, and should not depend on profit earned from sale of tree seed. Attempts to guide the development of national tree seed programmes towards economic sustainability in the ‘short-term commercial perception’, may result in dramatic loss of options and lead to national seed centres that only solve a fraction of their tasks. Such mis-guidance can thus lead to national tree seed centres that do not live up to their responsibilities as focal point in the national tree seed programmes, and for which it therefore may be difficult to see a true justification.

However, we also claim that the net investment in a well organised national tree seed programme in general will be many fold recovered by the value added to the plantation programme through the use of appropriate and improved planting material (cf. Graudal & Kjaer 2000, these proceedings), see also section 4.5 below.

4. Did something go wrong in the past years?
We will now return to the question raised in the beginning of the paper: why are several of the seed centres in a financial ‘crisis’ in these years, when the need for national seed programmes seems even more important than earlier in many countries?

Possible reasons for the ‘crisis’ can be grouped in the five following main points:
- The assumption that trade in tree seed constitute a viable commercial option in the medium term may be wrong. Maybe national tree seed programmes cannot generate income from sale of seed and services that can cover even a reasonable part of their costs
- The long-term investments of tree seed programmes may not have been taken sufficiently serious or may not have been sufficiently well understood by the investors, whether donors or governments, or even by the tree seed centres themselves
- The centres may not have been good enough to cover the needs of all (important) customer groups and to adjust to changing needs and priorities
- The ‘institutional arrangement’ used or created for managing the genetic resources may not have been appropriate. ‘Institutional arrangement’ refers in this context to who does what and how, in the chain from protection of the seed sources and harvest of the seed to the production and planting of the seedlings in the field.
• The initial investments may have been too high considering the macro-economic situation of respective countries and the economic importance of tree planting.

Some of the issues related to these five points are discussed in more detail below.

4.1 Is production and trade in tree seed a viable commercial option in the medium term?

It is said in section 3, that sale of tree seed constitutes a viable commercial option only for relatively few species. It could be argued that it is simply a question of price. In principle the sales price of tree seed should cover the production cost and provide a revenue in accordance with their value. Usually, this is not the case.

Seed and seedlings are often sold from seed centres at cost price, less than cost price or distributed free of charge. Therefore, self-financing through sale of seed and advice is at present in most places of Africa an unrealistic approach, and is probably likely to be so for a number of years. It is, however, no doubt important to charge for the seed being delivered through national tree seed programmes to emphasise the value of using appropriate seed. The price of the seed could be progressively increased to reach at least full cost recovery. Often the speed with which this can take place has probably been overestimated.

It could also be argued that if seed is such a high value commodity, providing the users with so much added value, they should be willing to pay enough also to cover the long term investments in conservation of genetic resources and genetic improvement. However, the value has to be appreciated by the customer here and now. The added values do not materialise until after 5-40 years depending on species and site. The long term nature of the production and the often non-quantifiable values associated with environmental protection and biodiversity conservation constitute effective barriers towards such appreciation. Compared to other commodities, the genetic quality of tree seed is difficult to appreciate at the time of trade, because the quality is revealed only after many years. In practice, the market price of tree seed, is therefore often decided by the cheapest available, where the quality is as uncertain as a draw in the lottery.

It is therefore apparent that even an assumption of ‘limited financial sustainability’, where it is expected that national tree seed centres can generate income from sale of seed and related services that can cover the costs of seed production only, is difficult to meet.

The more obvious it seems that it is as a fatal mistake to assume that national tree seed centres can generate income that can cover the costs and generate revenue to cater for required investments in conservation and improvement. However, such a mistake has no doubt often been made as an assumption for approval of external support.

4.2 The importance of long term investments and non-commercial activities

The ‘long-term interests’ in tree seed programmes comprise both productive functions, like investments in conservation of genetic resources and genetic improvement, and normative functions, like regulation and awareness raising. Some of them may actually turn out to be ‘commercial’ in the longer term. The investments will, however, typically have to be ‘non-commercial’ in the sense that the people who invest are not necessarily the same as the people who reap the benefits (Type B.II, cf. Table 1 and 2). The question of sharing costs and benefits in sustainable management of forest genetic resources is illustrated with an example from genetic improvement of teak in figure 1.
Figure 1. Flow of costs and benefits of a tree improvement programme in teak (Kjaer & Foster 1996).

The figure shows that a considerable but relatively moderate amount of investment capital is required. The time span from investment to gain is very long. The gain achieved is enormous. The point in this context is that the institutions or people who undertake the required research and development, and establish the orchards to produce the improved material are hardly ever the same as the institutions or people who establish the plantations and gain the value added from the initial improvement activities. In the example the gain is increase in wood production. Similar gains may be achieved for other products and for environmental services; in the latter case they are, however, more difficult to quantify.

Obviously, the teak case confirms that the sustainability and viability of tree seed production and supply and associated activities should not be assessed based on the earnings from sale of seed, but on the value added to the sector and to society. This is often said and implied by the development objective of national tree seed programmes, but hardly ever quantified and therefore often override by the narrow short-term goal of making business on sale of tree seed. Probably because business economics usually is based on a direct connection between the potential revenue of a commodity and its value to the customer, and because traditional business economics is used by the decision maker as the standard tool to evaluate the viability also of a tree seed producing unit.
An example based on data from Uganda can further illustrate the important economic potential that lies in organising good seed programmes. The net investment in establishment of the Uganda Tree Seed Centre has been estimated to approximately 240,000 US $/year over 20 years (FD/NTSC 1998). These investments will cover a number of activities of which one is supplying improved seed of *Eucalyptus* for the plantation activities. The industrial eucalyptus plantation programme alone covers around 1300 ha per year, and we will as an example take a closer look on the potential of increasing the value production on this area.

Let us assume that the seed programme manages to deliver (directly or indirectly) eucalypt seed to 865 ha plantation every year. This is 66% of the 1300 ha planned industrial plantation area, but it is often difficult to reach everybody. Now, we assume that using the best available seed (i.e. utilising present knowledge from Uganda and especially from other eucalypt breeding countries) will increase the productivity (volume/year/ha) with on average 20% (+2 cum/year & ha) from year one. Improved seed sources will be established as part of the seed programme, but these will not supply seed until after some years. After 8 years, the 865 ha planted every year can be based on seed from improved seed sources expected to grow 30% faster (+3 cum/year/ha) compared to the productivity in the presently established plantations. Tree improvement is a continuing process, and after 12 years the improved seed sources can be thinned based on established trials, which we expect will increase the productivity to 40% (+4 cum/year/ha) above the present level. If we assume the net value of the wood to be 20 US$/cum (value minus extraction costs), this increased production adds up to 0.5 mill cum over the 20 years (Fig. 2), i.e. a value of 10 mill. US$.

**Fig. 2. Increased growth in plantations following introduction of better seed sources**

![Increased growth from using better planting stock](image)

Note: Based on data from Uganda (FD/NTSC 1998). See text for more details

This means that the increased productivity of the industrial eucalypt plantations alone generates value within the 20 years that is twice as large as the investment in the full seed programme over the same 20 years. These gains are indeed real and easy to quantify. But still these gains cannot fund the national seed programme directly, because they are not realised until the improved eucalypt plantations are felled, and because the value falls into the pockets of the plantation owners.
The benefits added to the sector are harder to quantify for activities such as conservation and extension (cf. Type C in Table 1 and 2). The values associated with the healthy environment and biological diversity of a forest have usually been considered ‘free’ to everybody. Rehabilitation and conservation do, however, require resources. The cost of these resources cannot be put on the shoulders of the tree planters alone. The society represented by a public sector has to come in.

Such considerations are based on the assumption that investment capital is available for a fairly long period of time, up to 20 years or more, which is longer than most donors in practice are willing to commit themselves. Tree seed programmes therefore very easily become squeezed between two sides, on the one hand to generate revenue to survive in the short term, and on the other to make long term investments which will depend on uncertain sources of financing and in turn primarily generate revenue for others.

4.3 Who are the most important customers?
A narrow focus on short term revenue tends to lead to focus mainly on the customers with a strong ability to pay, i.e. the organised enterprises referred to above. It is appealing and initially probably also wise to focus on user groups who can pay and who demand well-known species which are easy to handle. Where the ability is linked to external support (e.g. donor support), it may however disappear, sometimes before expected. Where the ability is linked to strong business investment capacity, they may embark on their own seed production and improvement programmes (cf. section 3.1) and will thus cater for their own needs. Such private sector interests and engagement are of course positive and should be stimulated. Furthermore, the ‘strong’ customers tend to cover a smaller and smaller share of the ‘tree planting market’ in the African countries.

Tree seed centres have to adjust to important changes in the surrounding world. Tree planting is generally increasing. At the same tree planting patterns have been changing. More and more tree planting is done on a small scale and in combination with agriculture. The justification of national tree seed programmes will often to a large extent be found outside the traditional forestry sector. The small-holders, farmers and communities, may in the long term constitute the economic foundation for the tree seed centres. Some of the implications of this development for the organisation of tree seed programmes are briefly dealt with by Graudal and Graudal & Thomsen (both these proceedings).

The challenge posed by organisation and implementation of integrated tree seed programmes in support of small scale plantings has arrived in a period, which otherwise would have been for consolidation for several national programmes. Among the means to meet this challenge would be a movement from operational control of tree seed supply to users towards promotion of sustainable operations and self-sufficiency among users. A serious problem is that such means require new investments at a time where these seem difficult to mobilise. However, investments required are not necessarily large.
4.4 Who should do what and how?

The operational structure of a tree seed programme typically consists of a central co-ordinating unit (often a tree seed centre) and a more or less consciously organised network of stakeholders implementing different aspects of the programme: seed supply, seed research, seed source development and tree improvement, genetic resource conservation, training, marketing, extension, seed certification, approval and monitoring of seed sources, and control of seed in trade.

The role of the various stakeholders involved and the economic and ecological factors determining the organisation of tree seed programmes are discussed in some detail by Graudal and Graudal & Thomsen (both these proceedings). The distribution of tasks and collaboration among the stakeholders in the network may be the result of strategic considerations and planning. More often, however, it is relations which have been established ad hoc over time as a result of mutual influence and interaction. Several tree seed programmes have made an attempt to prepare and implement a strategy to promote this interaction in support of the overall objective of improving the benefits of growing trees. Such a strategy has to consider the relation between the different parts of the tree seed sector and their interaction with stakeholders. The purpose is to provide guidance for finding the implementation arrangements best suited to achieve the overall objective.

A strategy is needed to:

- Define responsibilities and activities of the operational structure at national and local levels concerning exploration of genetic variation, seed source development and management, seed collection and handling, and management of conservation stands
- Provide a framework for collaboration among institutions and other stakeholders working in the sector
- Provide a policy framework to guide an appropriate use of reproductive material

Technical and biological aspects of seed procurement, tree improvement and gene conservation can be difficult enough to deal with but the development of an appropriate and sustainable institutional framework is probably the most complex and challenging task of a national tree seed programme. The difficulties involved and the time required have no doubt often been underestimated and thus contributed to the present ‘crisis’.

The extent of complexity is realised when looking at some of the questions that were raised for the discussions on institutional development in Forest Genetic Resources at the Nairobi Workshop in December 1999:

**Organisation of seed supply to farmers of a large number of species, including species with recalcitrant seed**

- Should seed be traded locally?
- If so, which institutions can be involved?
- How can the potential gain from tree improvement be realised? and how can gene conservation be integrated?

**One or more institutions?**

- Should all tasks related to management of a national forest tree seed programme be managed by a single national organisation, or must it rely on co-operation between several ‘organisations’?
- If so, which?
The role of the private versus the public sector

- Can national tree seed programmes generate income from sale of seed and services that can cover their costs?
- Can national tree seed programmes generate economic, social and/or environmental benefits on a national level that can cover their costs?

Who knows the needs and the priorities best?

- The user or the 'expert'?

Organisation within research or production?

- Should NTSCs be organised within research or within production?

How should supportive research and development be organised in order to support better use of forest genetic resources of desired species?

- National Universities
- National Forest Research Organisations
- International (Regional) Research Organisations or Networks?
- National Tree Seed Centres?
- Co-operation between two or more of the above

Many of the questions have already been touched upon and will not be discussed further here.

4.5 What is an appropriate investment level?

Any country with substantial tree planting activities will benefit from a well organised tree seed programme. Aspects of organisation are discussed above. But how large and how sophisticated should the programme be? As illustrated in section 4.2, economic sustainability in the broad sense may in fact not require a very large planting programme. But what does ‘affordable considering the general macro-economic situation of the country’ mean in practice?

In order to evaluate the possibility of a national tree seed programme to continue after external support ends, it is necessary to estimate the running costs and the possible earnings from seed sale in the medium to long term. These will of course vary from country to country. After the investment and initial capacity building phase, which often has been set to 5 years, an annual budget to cover recurrent costs of running a national tree seed centre will be required.

The experience of Danida Forest Seed Centre from support to establishment of national tree seed centres in a number of developing countries (1986-1999) indicates capital costs in the range of 0.5 to 1.5 million US$ and recurrent annual costs in the range of 100,000 to 200,000 US$ (including all national staff and running costs; and including seed source establishment, gene conservation and some training and extension activities). These centres follow the traditional model with a central co-ordinating unit fully or partly responsible for most of the functions referred to in the beginning of section 3. Experience further indicates that under favourable conditions proceeds of seed sale can provide a recovery of recurrent costs of some 50 % within 5-10 years. The prospects of financial self-sufficiency would thus seem to be limited. ‘Financial sustainability’ will therefore depend on the ability and willingness of the Government to provide an annual budget in the range of 50,000 to 100,000 US $.

Cost-effectiveness of seed procurement may sometimes be improved through increased decentralisation and more involvement of the private sector, whether commercial or voluntary.
A government contribution of less than US$ 50,000 per year is, however, in most cases hardly sufficient.

The time perspective of external support to many African tree seed centres was in the planning process anticipated to be 15-20 years. However, in practise, the period of support has typically been shorter. At the same time, attempts to target affordable levels of investment have often either been neglected or failed. Consequently, both capital and recurrent costs may have been too high in some projects. It would probably not be fair to talk about ‘white elephants’, but there may have been a tendency in that direction, generally caused by a too optimistic view on the business development of the tree seed market and too forced capital investments.

5. Summary of conclusions: the challenges ahead of tree seed programmes

We will here summarise some of the points raised above and suggest some issues for further consideration.

1. The establishment of an integrated national tree seed programme is fairly resource demanding. The implementation of the programme requires considerable know-how, technical ability and sense of priorities. Some of the activities will in turn become financially self-reliable, whereas others will continue to require public support. The value of such a programme can however be substantial, and the programme cannot be assessed on the direct income generated from seed supply in a narrow commercial sense. The activities have to be assessed on the values added to the tree sector and the environment as a whole.

2. Attempts to guide the development of national tree seed programmes towards economic sustainability in the ‘short-term commercial perception’, may result in dramatic loss of options and lead to national seed centres that only solve a fraction of their tasks. *It is necessary to raise awareness among investors and decision makers of the large values that can be protected and generated by a tree seed programme to mobilise the financial support required.*

3. Focus on short term revenue leads to programmes that target customers with the strongest ability to pay, i.e. typically fairly well organised, and well-off, enterprises, despite the reality that *it is the small-holders, farmers and communities, who plant most of the trees and therefore most likely constitute the primary foundation for the tree seed centres in the long run.*

4. Focus on short term revenue may also have reduced the attention and consequently the success of many tree seed centres in addressing *their most important tasks: to be the focal point in planning, co-ordination and implementation of seed procurement, seed source use, tree improvement, and gene resource conservation,* and thereby improve the benefits from tree plantings.

5. The balance between implementation of existing technologies and development of new technologies is important. New technologies are often needed to improve the propagation and use of local species. However, too much emphasis is often put on research, and too little on practical implementation of simple, already known, methods and routines. The research needs should be recognised by the national research institutions, universities or agricultural
research organisations, and a national tree seed programme should contribute to defining the research agenda but rarely be the implementing research agent. Institutional co-operation is very important.

6. Technical and biological aspects of seed procurement, tree improvement and gene conservation can be difficult enough to deal with but the development of an appropriate and sustainable institutional framework is probably the most complex and challenging task of a national tree seed programme. Among the challenges is the change of focus from operational control of tree seed supply to users towards focus on networking and promotion of sustainable operations and self-sufficiency among users. The difficulties involved and the time required have no doubt often been underestimated and thus contributed to the present ‘crisis’.

7. Seed centres have often been based on an assumption that external support can be terminated after 15-20 years. In practice, the period of support has typically been shorter. At the same time attempts to target affordable levels of investment have either failed or been neglected. Consequently, both capital and recurrent costs of national tree seed centres may often have been too high. It is extremely important to be cost conscious. Despite the argument for public sector support put forward in this paper, it must not be a ‘sleeping pillow’. Increasing the revenue from promotion and sale of seed and services should continue to be an asset.

8. The balance between (i) the development of a centrally organised normative (public) seed supplying organisation with some degree of financial self-reliance, (ii) support to more decentral, and locally based activities and (iii) the development of private sector interests is crucial.

We live in a dynamic World where changes appear continuously, and response to these therefore also is required continuously. In “Alice in Wonderland” the “Red Queen” tells Alice that “she needs all the running she can just to stay in the same place”. This has given name to the so-called “Red Queen”-theory in evolutionary biology, which states that only species and populations that are able to rapid adaptation to changing environments will survive in the long run. One can state that the same goes for all organisations including tree seed centres and tree seed programmes. Only the ones that can continue to adapt and find new ways will survive. These new paths will be different for different countries and institutions, and can only be found locally, and by joint efforts of the stakeholders. The role of regional and international co-operation will be to catalyse and support such efforts.

Issues which need further consideration to meet the challenges listed include:

- Organisation of seed supply in support of rural development, to the benefit of small scale tree planting people.
- Better interaction between public and private sectors in national seed programmes
- Finding the right priorities for national seed programmes and development of such programmes ‘step by step’, rather than presenting a pre-prepared package.
- Low cost options that are affordable for more species, in more countries and regions, and over larger areas
- Specification and quantification of the value of the different activities including values of environmental protection and conservation. Methods and cases
• Increase in the awareness among users, national governments and development assistance organisations of the skills and values associated with national tree seed programmes.

6. References