



TREE NURSERIES

- The Key Issues

Plantation Guideline Series

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One of the essential components of successful plantation establishment is the availability of high quality tree seedlings. Whether you are buying seedlings from an external nursery or producing them in your own nursery, this guideline will help you focus on the most critical issues - especially how to identify a good seedling, the importance of good planning and timing, using improved seed and the need for experienced and reliable staff. Technical improvements to the traditional nursery system and clonal nurseries are also discussed.

1. Introduction

This guideline is not a detailed nursery manual. It is intended as a guide for those involved with commercial tree planting – to help them identify the most important issues to consider when either buying tree seedlings from an external nursery or raising them in one's own nursery. Importantly, the guide also illustrates what we mean by “a good quality seedling”, whichever nursery it was raised in.

The level of tree nurseries in Uganda is very basic at present, with all of them using plastic tubes, using mostly top-soil and with sowing, watering and root pruning all being carried out manually. As commercial forestry expands here, however, some of the larger planters are starting to look at improvements, especially towards a containerized, soil-less nursery system. The main features (and pros and cons) of such improved nursery systems are dealt with later in this guideline: the rest of this guideline assumes people are using the traditional nursery system.

It is important also to differentiate between what we would define as a commercial nursery compared with the many small, roadside nurseries. Thousands of tree nurseries have been (and still are) established in Uganda. These small businesses are often justified by the rural employment opportunities they provide rather than quality or how many trees are planted out and reach maturity.

Because it is almost impossible to control the quality of trees from so many small nurseries, the Sawlog Production Grant Scheme (SPGS) often recommends the smaller commercial growers to rather buy from one of the nearby larger, established nurseries. The smaller nurseries can, however, produce excellent quality seedlings provided they follow the basic rules as outlined in this guideline.

Commercial tree planters - especially those under the SPGS - are in the business of establishing fast growing, high yielding, timber plantations. To establish such plantations requires a regular and timely supply of high quality seedlings, raised from selected seed sources: this can only be achieved by having control over one's nursery or trusting in a reputable external nursery. This guideline should help you decide what is best for you.

2. Do You Really Need To Start your Own Nursery?



This is the question we often ask those new to the business of commercial forestry in Uganda. The vast majority of people we meet who are planning to start commercial tree planting here, want to immediately start their own nursery. We often get them to consider whether this is really necessary.

Starting off in commercial forestry is a steep learning curve – as many people are now finding out to their cost! Establishing and managing a nursery is expensive and also another part of the business that can easily go wrong – particularly if the investor has little or no experience in commercial tree growing.

Tree nurseries require skillful management and a reliable workforce. They require regular watering (usually twice daily), experienced staff and constant supervision. It is often a question of scale and experience. For investors planning to plant over 300 hectares or so per year, having their own nursery is more likely to make sense. For smaller growers, however, we often recommend them buying their seedlings from an established and reputable nearby nursery.

3. Recommended Tree Nurseries in Uganda

There is at present no independent assessment of tree nurseries in Uganda (though we hope this will come in time). This means that we do not accept responsibility for quality or other services provided by the nurseries we recommend. The nurseries we list below, however, have at least attained a level of management that leads us to recommend them to private growers. They have all benefited from significant improvements, mostly with the support of the EC-funded Forest Resources Management & Conservation Programme (the parent programme of the SPGS) since 2002.

A).National Forest Authority (NFA) nurseries:

- Arua. Contact: Galima Stephen
– 0772 925 762.
- Gulu. Contact: Ouna Jimmy
– 0772 645 040.
- Katugo(Nakasongola).Contact:Okurut Stephen
– 0772 966 218.
- Kityerera(South Busoga, Mayuge)
Contact: Okurut Stephen
– 0772 966 218.
- Masindi. Contact: Esimu Robert
– 0782 241 870.
- Mbarara. Contact: Mununuzi David
– 0772 466 498.
- Mubende. Contact: Sentongo Joseph
– 0772 468 691.
- National Tree Seed Centre: Namanve (Jinja Road, Kampala).Contact Khaukha Stephen
– 0772 561 227.

NB1. Prices vary but as an indication – *Pinus caribaea* (improved seed) range from UShs 2-300 per seedling; *E.grandis* UShs 100-150 each.

NB2. For the latest information on tree seedling (and seed) availability, check the latest SPGS Newsletter, published every two months and available free from the SPGS office or download from www.sawlog.ug

B). Private Nurseries:

- Busoga ForestryCo.:(Bukaleb CFR,Mayuge). Contact: Byamah Jossy
– 0772 471 164.
- Global Woods(U)Ltd Kikonda CFR,nr.Hoima). Contact: Kay Windhorst
– 0782 568 291.
- Kamusiime Association: Bushenyi &(from late 2006 Kampala: Contact Mwebaze Brenda
– 0772 452 680.



The NFA's National Tree Seed Centre nursery has expanded rapidly since 2004 and is producing good quality seedlings for their own planting and commercial seedling sales.

4. Check-List for Buying Seedlings

If you are going to source your trees from an external nursery, we strongly recommend that you do the following:

- Study regional rainfall records (and talk to the locals!) and plan to plant early in the period when the most reliable rains are expected.
- Order seedlings 6 months in advance and pay a deposit (usually 30%) in advance.
- Specify not just the species but the exact seed origin of the plants.
- Allow for seedlings for beating up too (up to 20%extra is commonly required).

- Clearly specify the time period when you expect the seedlings to be ready(NB. remember that you will often plant over a period of some weeksnot all in one go).
- Allow around 4-5months from sowing for *Pinus caribaea* and most tropical pines; 3 months for *Eucalyptus grandis*.
- Specify the size required: 20cm is recommended (min. 15 cm; max. 25cm).
- Plan to have the planting site prepared and preplant weeded immediately before the expected planting time (preferably early in the rainy season).

- Regularly check with the nursery the state of development of the plants so that land preparation and pre-plant weed control etc. is coordinated.
- When taking delivery of the trees, be prepared to reject seedlings that do not meet the required specifications the means of transporting the seedlings efficiently to the planting site.

NB. If you are selling seedlings to others, we urge you to plan well (especially purchasing seed and sowing in time) and also to communicate regularly with your customers (especially with regard to any possible delays or shortfalls in numbers for whatever reasons).



5. Before Starting Your Own Nursery: Some Important Considerations

Before starting your own nursery, ask yourself the following questions:

- Is there an opportunity to sell seedlings to other growers in the vicinity and if so, what seedling numbers can I expect to sell and at what price?
- Do I have a suitable site (especially important are water availability, accessibility and having a well drained, airy site that could be expanded if required)?
- Where will I get an experienced Supervisor/ Manager required to run my nursery?
- Do I have workers that I can rely on to be there every day to water and protect the seedlings?
- Do I have a secure store to keep chemicals, seed, tools etc.?
- Where will I purchase good quality seed and will it be available when needed?
- Do I have enough experience to budget and plan accurately or do I need assistance?
- Do I have sufficient funds to start?

6. Tree Nurseries: the Key Issues

Assuming you are starting (or already running) your own nursery, then the following issues are important:

- a. Budget for experienced and reliable staff.
- b. Ensure the staff are trained well, closely supervised and understand the need for somebody to be present every day to water and protect the seedlings.
- c. Prepare beds and fill pots well in advance of sowing, allowing time to water and settle the soil in the pots.
- d. If local soil is heavy (i.e. with a high clay content), mix in river sand to improve drainage.
- e. If growing pines, mix some organic matter from a mature pine plantation with the soil (this will contain the necessary mycorrhiza fungi that pines need to grow well).
- f. The use of fertilizers is also recommended: when used properly, fertilisers encourage fast growth (less time in the nursery), strong root development and a healthy seedling.
- g. Find out what species (and specific seed origins) are required or will sell.
- h. Acquire improved seed in good time and ensure it is stored correctly (in dry, cool and dark conditions). NB. The huge demand for improved seed in Uganda over the last few years (especially for *Pinus caribaea* and *E. grandis* seed orchard seed) can lead to shortages at crucial times.
- i. Find out from the supplier the expected germination of the seed and also calculate the numbers to be raised (the area to be planted or the seedling numbers expected to be sold).
- j. Compensate for low expected germination by double sowing a proportion of the pots.
- k. Carefully follow any pre-germination treatments recommended from the seed supplier (e.g. allowing time for acclimatization or soaking).

- i. Time sowing so that the seedlings will be the right size (20 cm recommended) at the time when the main rainfall is expected and land preparation should be complete: 4 months is the usual time for *Pinus caribaea* and most tropical pine species, 3 months for *Eucalyptus grandis*.
- m. Regular watering is vital and can be very time consuming if not available on site: where possible pump water to holding tank(s) near to the nursery and have stand-pipes in the nursery. Otherwise staff will spend most of their time lugging water around.
- n. Ensure everyone knows what sort of quality and size of seedling is required (refer photos).
- o. Minimize the ‘pricking-out’ of seedlings as this is a common source of seedling root problems later on: for this reason, direct sowing is recommended especially for the larger seeded species, like pines.
- p. Be prepared for diseases (especially damping-off fungi): copper oxychloride is the standard precautionary treatment but other fungicides should be available as a backup. Damping off can wipe out thousands of young seedlings extremely quickly.
- q. Have a strict nursery hygiene policy (for discarding weeds and any dead or dying plant material) and also encourage good air circulation in the nursery: these measures reduce the risk of damping off.
- r. Manipulation of shade is also important to protect the seedlings when very young and encourage maximum growth as they develop; also to protect the seedlings in bad weather (one bad hail storm can wipe out an entire nursery).



Training one's nursery staff well is essential if you want to produce good quality seedlings at the right time. Here people are learning how to directly sow pine seed.

- s. The seedlings must be regularly checked for their root growth: root pruning may be necessary if planting is delayed (this can be done by simply moving the pots sideways to break the emerging roots).
NB. Do not plant seedlings earlier than 2-3 days after root pruning as they will be stressed and need time to recover.
- t. Reduced watering can be used as a tool to ‘harden-off’ seedlings out: this produces a tougher seedling more able to withstand the stress of being planted out.
Allowances must be made for culling (i.e. rejecting poor seedlings) – at least 15% extra should be allowed.
NB. Culls must be discarded: they will never make strong seedlings and thus shouldn't be sold by any professional nursery.
- u. Never carry seedlings over from one season to the next: the roots become ‘pot-bound’ and when planted out cannot respond quickly.

- w. Overgrown seedlings will not grow well when planted and are frequently unstable.
- x. Water seedlings well immediately before they are transported to the planting site.
- y. Ensure the seedlings are transported in such a way that minimizes damage: appropriately sized boxes or trays are recommended rather than piling them on the back of a vehicle.
- z. If possible transport seedlings during the cooler parts of the day and cover them from the hot sun.
- aa. Keep records of all seed purchases, sowing dates, germination dates and %, seedling sales etc. Each nursery bed should be clearly labeled and a separate record kept in the nursery office.

Nurseries in Uganda: the bad ...



Old seedlings like these should be discarded: they will not grow well when planted out, having very poorly developed roots.



The consequence of poor seedlings: trees die after 1-2 years in the field. The deformed root systems can be clearly seen when the trees are dug up.



*This grower thought he could save money by collecting *E. grandis* seed from their own plantation: the consequence is very variable seedlings. For commercial planting, only buy improved seed from SPGS recommended sources.*



Another common sight: over mature seedlings. Either the rains were late or sowing was too early. Such plants will be severely stressed if planted out.



Pine seedlings heading to the field, being packed in the back of a truck. They will be stressed (and some undoubtedly damaged) when planted out.



A poor seedling like this should have been culled and discarded at the nursery.

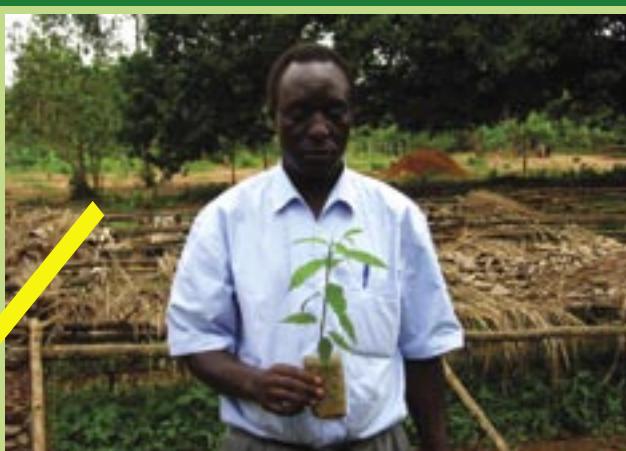
... and the good practices



An ideal *E. grandis* seedling ready for planting out. 2:1 shoot:root ratio is ideal.



Perfect planting: a healthy Pine seedling planted deeply into well prepared soil.



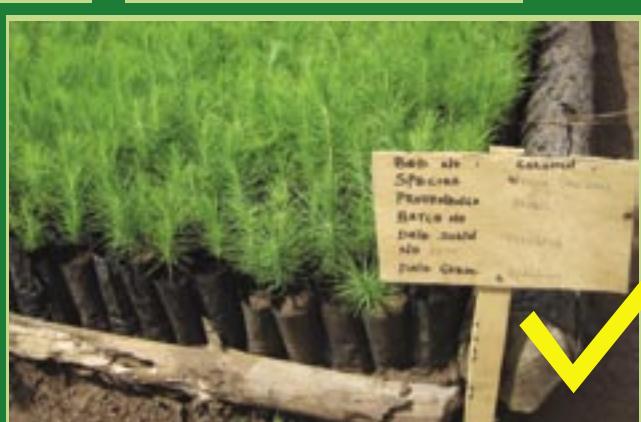
An excellent Musizi (*Maesopsis eminii*) seedling: 20 cm (measured from the root collar) is the ideal height for seedlings to be planted out.



Good germination evident in this nursery – though the label needs to be a bit more permanent!



The NFA's Katugo nursery in 2004: an example of where technical improvements are needed when production reaches this scale.



Excellent pine seedlings from a small private nursery almost ready for planting out.

7. Common Problems & Solutions

- 1 **Variable quality and growth rates:**
Only buy recommended improved seed; cull (sort) seedlings better & discard rejects; discard late germinants.
- 2 **Seedling numbers less than expected:**
Sowing seed too deep; poor storage of seed; follow any pre-germination treatment recommendations; double sow % to allow for low germination.
- 3 **Seedlings are too large/too small when rains arrive:**
Plan better; sow at correct time; stagger sowing; communicate better with field / customers.
- 4 **High seedling deaths** (stems appear to rot when very young):
Routinely drench with fungicide at sowing; keep systemic fungicide(s) in reserve.
- 5 **Compacted soil in pots:**
Mix sand with soil to improve drainage; check over-watering.
- 6 **Poor root development:**
Reduce pricking out (or supervise better); use fertilizers; routinely check root development (see photo above).
- 7 **Root coiling in pots:**
Get them planted out (or sold)!; root prune older seedlings frequently.
- 8 **Chlorosis (yellowing) of foliage:**
Apply fertilizers (only after trials to determine dose); check watering.
- 9 **Weaklooking seedlings:** Reduce shade; fertilise seedlings.
- 10 **No space to expand nursery:** Select site carefully before starting nursery.
- 11 **Shortage of water at critical times:**
Before starting the nursery, ensure water supply is adequate (10 lts water per m² nursery bed per day is a guide); have an emergency water supply available.
- 12 **Customer does not pick seedlings:**
Communicate regularly with customer/field staff; insist on an advance fo external orders.



8. Improved Tree Nurseries

The traditional nursery system described so far in this guideline is capable of producing tree seedlings of excellent quality. It is also a system that is understood reasonably well by many in Uganda. As more commercial growers emerge and the demand for seedlings rockets, however, some of the drawbacks of this old system are becoming apparent. In particular, the logistical problems of transporting ever increasing amounts of top-soil, sand etc. and also the heavy pots to the field become very difficult.

This traditional nursery system also can lead to root problems, with the need to regularly root

prune once seedlings have reached a certain age/size. Watering also becomes extremely labour intensive as the nursery expands. Thus it is not surprising that the larger growers in Uganda are now looking to improve their nursery systems. The next section discusses the key features of these improved nursery systems, being based largely on the experience in southern Africa. South Africa adapted the 'planter-flat' nursery system (developed in the USA for vegetables) for use in forestry from the mid-1970's. The system was based on high density polystyrene trays suspended on tensioned wire tables (or racks)

and irrigated by various spinkler systems. The growing medium was mostly composted pine bark, with the seeedlings' nutrient requirement usually being added through the irrigation system. This nursery system proved ideally suited to fast growing pine and eucalypt seedlings.

In the past 30 years, the trend in all the countries with large scale plantation development programmes has been towards more centralised nursery production. The polystyrene trays have largely been replaced by tougher, plastic 'Unigro' trays (or something similar) with individual plastic inserts. There has also been a major shift towards the use of clones (especially rooted cuttings). In Uganda, even though most of the commercial tree planters are still small, those now planting more than 300 ha per year (around 4-500,000 seedlings), are experiencing the limitations of the traditional nursery system as described in this guideline. These larger growers are all starting to look to improve their nursery systems. But before rushing into a more 'high-tech' nursery, however, it is important to consider their pros and cons:

ADVANTAGES:

1. Very high production capacity possible.
2. Ability to better control seedling development (especially through the use of irrigation and also liquid fertilisers).
3. Direct sowing possible (even with eucalypts).
4. Produce a compact, fibrous root system that root prunes itself (the trays being suspended off the ground).



Global Forest Products's seedling nursery - near Sabie, RSA. Here *Pinus elliottii* seedlings are being raised.

5. The individual tubes make it very easy to sort (grade) seedlings.
6. Seedlings less likely to be damaged in transit to the planting site.

DISADVANTAGES:

1. Capitally intensive: trays, shade, growing medium, irrigation equipment etc. all needs to be imported.
2. Less forgiving than the old system: the growing medium does not hold water long and must not be allowed to dry out.
3. Availability of the growing medium: in Uganda there is no source of pine bark; trials needed to find alternatives.
4. The modern nursery requires experienced management (e.g. mistakes with fertilising through the irrigation system can be disastrous).
5. It is more difficult to hold back plants in such systems (e.g. if the rains are late).



SAPPI's massive Ngodwana nursery in RSA showing trays of *Pinus patula* seedlings. Irrigation is by automated overhead sprinklers. This nursery produces up to 17 million seedlings per year.

9. Raising Clonal Plants

The photographs on this and following pages (from South Africa, Australia and Uganda) show clearly why people get excited about clonal forestry! Some of the growth rates and uniformity achievable with clones on selected sites are impossible to match with seedlings.

Other advantages of clones are that they - especially hybrids - can be tailor-made to combine desired traits of each parent and also can be 'designed' to suit specific sites.

For example, the GU hybrid (*E. grandis* x *E. urophylla*) is better adapted to hotter sites than pure *E. grandis* yet retains the good stem form and ability to grow as fast as *E. grandis*. Similarly the PEE x PCH (*P. elliottii* var. *elliottii* x *P. caribaea* var. *hondurensis*) clone combines PEE's better stem form, tolerance of wet sites and denser wood with PCH's better growth rate and branching characteristics.

On the down side, clonal plants are usually 2-3 times the price of a seedling, largely due to the heavy capital investment required to produce the right environment for the cuttings to root. By their very nature, all the plants of each single clone are identical. The reduced genetic base of clones thereby increases the risk of pests and diseases (though this risk can be much reduced through careful planning).



3 month-old hybrid Eucalypt (GU - *E. grandis* x *E. urophylla*) clonal cuttings at SAPPI's Kwambonambi plantations in South Africa.

Clonal nurseries are more complex than seedling ones and require highly specialised knowledge to establish and manage. There must also be a tree breeding programme in place to provide the continued technical support for such a development.

The Forestry Research Institute (FORRI) introduced 12 *Eucalyptus* clones (from Mondi, RSA) to Uganda in 2002/03 and established them at 14 trial sites throughout the country. Although the results from these trials have not been made available, the early performance of some the hybrid GC (*E. grandis* x *E. camaldulensis*) and GU clones is clear to see. Despite considerable interest, however, to date there has not been any commercialisation of *Eucalyptus* clones here.



One of FPQ's nurseries in Queensland where mostly hybrid pines (PEE x PCH) are being raised from cuttings. Such nurseries are capable of producing many millions of plants though the investment is high.

Of particular interest to Uganda is Forest Plantations Queensland (FPQ)'s breeding programme involving PCH in Australia. PCH is by far the main commercial species suited to many sites available for large scale planting in Uganda. FPQ are mainly interested in PCH for its ability to hybridise with *P. elliottii*, which produces trees well suited to the infertile, poorly drained sites in southern and central Queensland. Following a visit in mid-2006, the SPGS will continue to explore the possibility of collaboration with FPQ. Ensure you receive the SPGS Newsletter for regular updates.



3 year-old hybrid clonal Eucalypt (GUs & GCs) trial in Mayuge, eastern Uganda, showing clear potential for high yields.

10. Indigenous & Other Species

Whilst pine and eucalypt species are the main focus for commercial growers, there are also other species that nurseries should consider growing, depending on the location and suitability of certain species in such areas. These include hoop pine (*Araucaria cunninghamii*), teak (*Tectona grandis*) and the indigenous Musizi (*Maesopsis eminii*). It is always good to encourage nurseries to also raise some of the well known (and fast disappearing) indigenous species, like Mahogany and Mvule. There are also some multi-purpose agroforestry species that may be in demand as well as shade and hedging species (e.g. *Cupressus lusitanica*). Refer other SPGS Plantation Guidelines - No. 5 - *Tree Species*; No. 6 - *Site-Species Matching* and No. 13 - *Other Timber Species*.



Fresh GU cuttings just placed in trays at SAPPI's Kwambonambi clonal nursery in RSA. The leaves are cut to reduce transpiration. The medium is vermiculite.

11. Further Reading

The FRMCP commissioned a very relevant study in 2003, which is available from the SPGS:

- Temmes M (2003). *Report on Nursery Management in Uganda*.

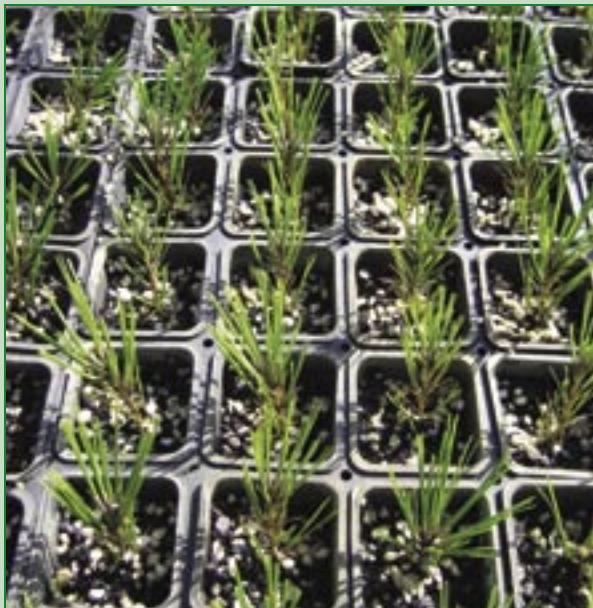
Other useful reference sources are:

- Evans, J & J. Turnbull (2004) *Plantation Forestry in the Tropics* (3rd Edition).
- Longman, K.A. (1998) *Growing Good Tropical Trees for Planting. Tropical Trees: Propagation & Planting Manual Vol.3*. Commonwealth Science Council

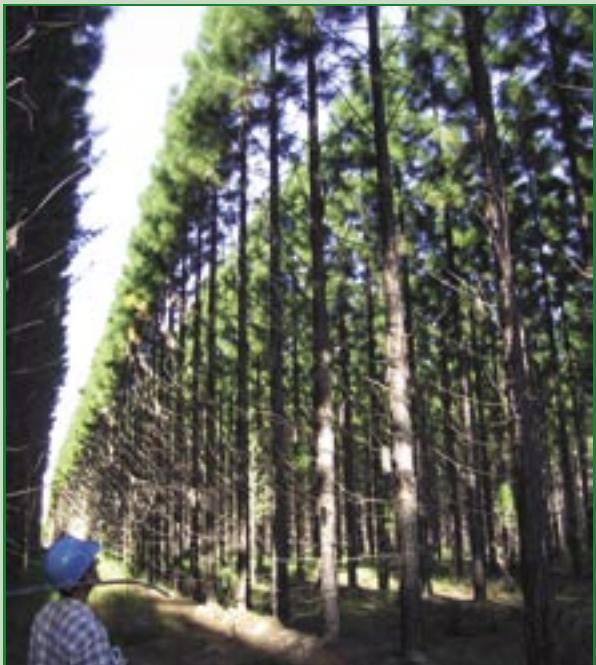


A well rooted GU cutting ready to plant. The finger is pointing out the recommended planting depth (to the top of the original cutting): SAPPI at Kwambonambi, RSA..

The traditional nursery method employed in Uganda for raising tree seedlings is capable of producing plants of excellent quality, provided some basic rules are followed and there is good planning and management. When seedling numbers exceed 500,000 per year, however, serious consideration should be given to introducing technical improvements to both increase the scale of production, improve the quality of the planting material and at the same time reduce the unit cost. This guideline discusses the merits of various plant production systems.



Trays of hybrid pine cuttings at Forest Plantations Queensland's nursery in Australia. These are select PEE x PCH crosses that were first tested in trials and the best ones are now being multiplied up.



and 10 years later...the resulting stands look like this: fantastic uniformity and excellent growth rates.



Traditional nurseries like this are appropriate for small scale growers only if there is no alternative commercial supplier nearby.



Excellent plants like this *Pinus caribaea* var. *hondurensis* planted by a private planter in Bushenyi came from the traditional nursery system. The seed came from FPQ's Queensland seed orchards.



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