Seedling quality

Quality versus quantity

A nursery manager's most important goal is to produce quality trees. Quality is more important than quantity. It is a common mistake in nurseries to concentrate on the total number of trees produced and neglect their physical and genetic quality. It is better to produce a few good trees, than many poor ones. Improving plant quality may mean that the farmer plants fewer trees, but the growth and survival of these trees will be superior.

Good plant quality is the basis for tree planting success. It is not worth a farmer's effort to transport plants to the field, prepare an area, plant and maintain trees unless they are of good quality. A poor quality tree will always be a poor quality tree even if planted on a well-prepared, good site. In the field, each poor quality tree wastes space and resources leading to low site productivity. High quality trees have a higher survival rate and faster growth in the field than poor quality trees. Fast growth allows a tree to outcompete weeds and reduces the initial labour costs of establishment. Fast growth also enables a farmer to harvest wood or tree products sooner, increasing the return on the farmer's investment. We are producing trees for people's livelihood; they depend on having high quality trees.

Seedling quality has two main aspects. The first is the **genetic** quality or the source of the seed. The second component of seedling quality is its **physical** condition when it leaves the nursery. Improving genetic quality of seedlings requires a long term strategy of seed selection, while improving the physical quality can be accomplished in just one or two seasons.

Seed source quality

Farmers select only the best animals for breeding: animals that are small and sickly do not produce good offspring. Similarly, farmers use only the superior crops that have high yields and are resistant to disease for the next year's seed. These same principles should apply to trees. The characteristics of the parent trees can greatly influence the characteristics of the seedlings. The seed can determine whether the tree will grow well or poorly. Studies from around the world have shown that good seed improves survival, timber and fruit quality, and shortens rotation or harvest times. Because trees take longer to mature than crops or animals, thus making tree planting a long-term investment of labour and land, it is even more important to select only high quality seed.

The desired characteristics of the parent trees will vary depending on whether the trees are for wood, fodder, fruit, or medicine. A ***good nursery practice*** is to consult farmers

Consult farmers as well as forestry technicians when selecting the seed sources.

as well as forestry technicians when selecting the seed sources. Farmers often know additional traits which make their trees more valuable. It may be difficult to find some of the trees with the best traits because these are often the first to be cut down. Conserving some of the best trees within the community will ensure a future supply of seed.

Some desirable parent tree characteristics are:

- healthy trees with a large, well developed crown
- for timber trees, a long, straight trunk with few branches
- wood quality, such as high density, or straightness of the grain
- for fodder trees, palatability and digestibility of foliage (leaves that animals like to eat and are easily converted into energy)
- for fruit trees, low branching may be desired for easier fruit harvest
- fruit quality, such as sweetness or ability to be transported with minimum damage
- fast growth rate
- low susceptibility to (or ability to quickly recover from) disease or insect attack.

Select the parent trees well in advance, and plan a way to ensure sufficient seed is collected.

Collect seed from at least 30 parent trees that are at least 100 metres apart.

A ***good nursery practice*** is to select the parent trees well in advance, and plan a way to ensure sufficient seed is collected. Permanently marking the trees as seed sources may help ensure that they will not be cut down. Only mature seed from ripened fruit should be harvested. A ***good nursery practice*** for each species of tree is to collect seed from at least 30 parent trees that are at least 100 metres apart. If you buy the seed, find out how many trees were used. Using a large number of seed sources increases the gene pool or genetic diversity of the seedlings. Genes are the codes of information from the parent trees that determine how the progeny or offspring trees will grow. By using seed from many different trees, the probability of the offspring trees having good characteristics increases and ensures that the trees can better adapt to environmental changes. A ***poor, but unfortunately very common nursery*** practice is to collect seed from just one, two or three easy to

climb trees close to the nursery. If the seed is bad and does not germinate, the nursery crop could be lost. Collecting from just a few trees is also dangerous because it results in low genetic diversity. Trees with low genetic diversity are often more susceptible as a group to disease, or unable to adapt to changing environmental conditions such as drought. If an area is planted with trees from very few sources, in the future, our ability to chose the best seed sources and improve the characteristics of the trees is very limited.

Use seed from an area as similar as possible to the area where you are planting. For example, seed from a mountainous region should only be planted in a mountainous region and seed originating from the lowlands will grow best in lowland conditions. If you purchase the seed, ask for its origin. It is okay to mix the seed from different trees together for normal nursery production. For long term genetic improvement though, seed from each individual tree is kept separately and tested in field experiments. The best trees are then selected to serve as seed sources for the nursery.

The principles of tree domestication are similar to those used in agriculture: maximize the quality of tree products, maximize tree growth rates, ensure the adaptability of species to the planting site, and maximize resistance to diseases and pests. This is achieved by selecting the best seed sources and managing the trees under optimal conditions.

Seedling physical quality

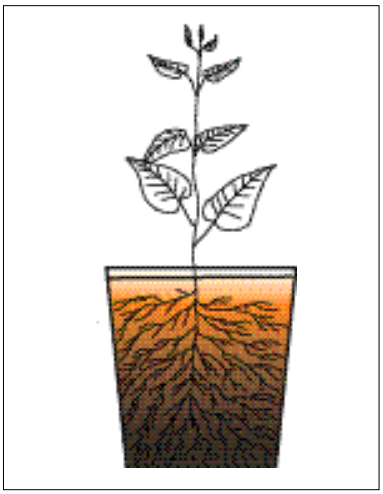
No single characteristic determines seedling quality. Seedling quality is a combination of height, diameter, plant nutrition, health, root size and shape. Together, these characteristics determine how well the plant will establish itself in the field, and they affect the rate of survival. Height alone is often not a good predictor of how a plant will grow in the field. A ***good nursery practice*** is to judge seedling quality by several traits.

Judge seedling quality by several traits.

Many of these traits act together and influence one another. The goal of producing the best seedling is to optimize these traits while producing specifically what is needed for a particular site. You will need to talk to foresters and farmers to find out the most important desired traits. For example, plants for dry, rocky soils may need to be short and be produced in small containers, whereas plants for flooded sites or active pastures may need to be quite large.

Quality tree seedlings have the following characteristics:

- They are healthy, vigorously growing and free of diseases.
- They have a robust and woody (lignified) single stem free of deformities.
- Their stem is sturdy and has a large root collar diameter.
- Their crown is symmetrical and dense.
- They have a root system that is free of deformities.
- They have a dense root system with many fine, fibrous hairs with white root tips.
- They have a 'balance' between shoot and root mass.
- Their leaves have a healthy, dark green colour.
- They are accustomed to short periods without water.
- They are accustomed to full sunlight.



A quality seedling

The following examples demonstrate how these traits enable the plants to be more resistant to transport and planting stress, and how they improve seedling growth and survival.

How quality traits work together

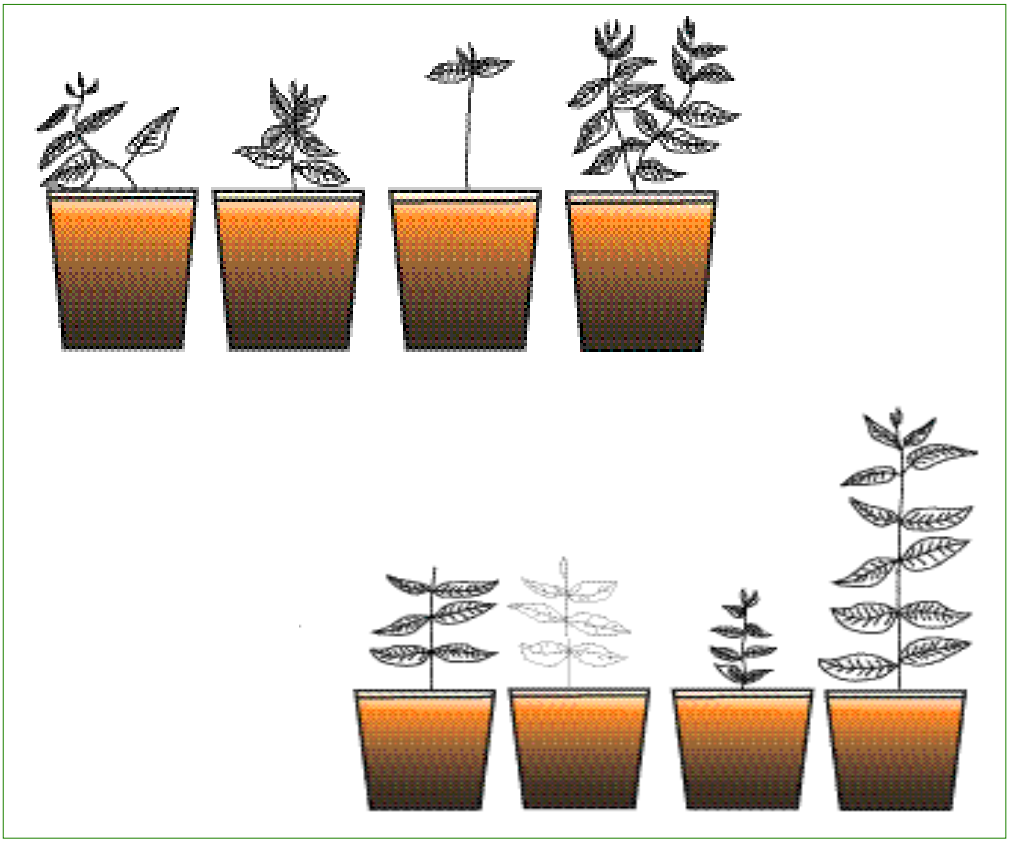
'Sturdiness' is measured by the relationship between height and diameter. If two trees are the same height Theand one has a larger diameter stem, then the latter is sturdier. A sturdy stem is less susceptible to transport and planting damage.

Stem diameter is often related to root size. Plants with large diameter stems often have large root systems. Diameter is a better predictor of root size than plant height is.

A 'balanced' seedling has a small to medium shoot system and a large root system. The shoot loses water through the leaves and the roots compensate for this loss by absorbing water and nutrients. 'Unbalanced' plants have too many leaves and too few roots. Balance refers to the mass or dry weight of the shoot and root — NOT to their length.

Assessing seedling quality

You do not need special equipment and it does not take long to survey seedling quality. When the seedlings are about 15 cm tall, choose at least 20 plants from each species for inspection. It is important to sample randomly, that is, not to pick only the biggest plants or only plants from one bed. Try to sample plants from all parts of the nursery and from each bed in the nursery. Choose one or two plants from each end and from the middle of each bed. Examine the plants thoroughly. Sixteen out of 20 plants (80%) should have the quality characteristics listed above. If fewer than 16 trees are of good quality, try the techniques suggested in this manual. Repeat this quality assessment at least once more about 1 month before the plants are taken to the planting site so that improvements can be made if necessary.



All of these plants exhibit poor quality. Starting at the top left they have the following problems: bent stem; too small; too few leaves; two stems; dead main shoot; yellow leaves (nutrient deficient); extremely small leaves; overgrown, 'unbalanced' shoot and root system.

Sacrifice a few plants to improve the quality of the total nursery production.

A ***good nursery practice*** is to sacrifice a few plants to improve the quality of the total nursery production. One of the best ways of examining quality is to cut open the container and observe the root system of several plants. Of course, these plants must then be thrown away. ***Do not plant these seedlings afterwards, because when inspecting the root system, the fine root hairs will get damaged, and the plants will either die or become badly stunted.***

Root deformities — the hidden curse

Root deformities below the soil line are the hidden curse in seedling production. They retard growth, cause the plant to lean or even fall over, and can result in the plant's death. Root deformities do not correct themselves over time — in fact, they become more acute as the tree grows.

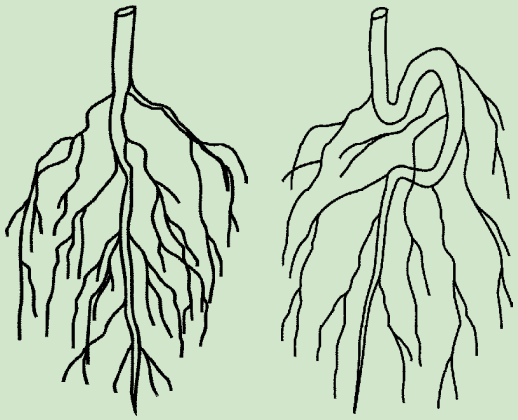
The main root should be as straight as a carrot, or if there is no main tap root, the many smaller roots should branch out without any pattern or strong bends. If the roots are in knots or coiled, they will eventually strangle the tree, or they may die, attracting insects or fungi that will damage the tree. There are two types of root deformities:

Root deformities caused by poor pricking out from the germination bed into the container

The deformities are generally within the first 10 cm under the surface of the soil or at about a finger's length. Often, seedlings are squeezed into holes that are too short for the root system. Roots are stuffed forcefully into bags or, while placing a seedling into a hole, the end of the root remains curled upwards. Because roots always want to grow downwards, they will bend back and grow into a 'knee' or even a complete loop. Nursery customers can check for these deformities by following the stem down with their finger. These plants should be refused because they will never grow well in the field.

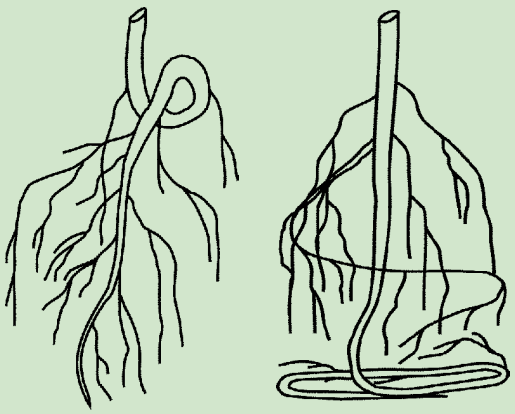
Root deformities caused by the bag

Smooth plastic bags cause the principal root to coil or spiral along the walls or at the bottom of the bag or pot. This inevitably happens when plants are left in the nursery too long. However, it can also happen to plants that are only a few centimetres tall. Plants commonly develop roots before they begin shoot growth. So even plants with small shoots may have long roots that are coiled at the bottom of the bag. These roots should be cut off immediately before planting.



Top (left) A good root system free of deformities. The tap root is straight, like a carrot. Notice the many fine root hairs that are important for the absorption of water and nutrients.

Top (right) A deformed root system caused by poor pricking out. Notice that the roots are twisted close to the surface of the container.



Bottom (left) Another deformed root system caused by poor pricking out. Here the main root was stuffed into a hole too small and the roots were twisted upwards. As the roots began to grow downwards, they formed a complete loop.

Bottom (right) A spiralled root system caused by the smooth surface of the bag. Notice that the roots are coiled at the bottom of the bag — not near the soil surface.

*A **good nursery practice*** is to regularly survey seedling quality to correct problems through appropriate nursery management. Some problems, and suggested solutions, are:

problem	solution
Roots knotted or twisted from poor pricking out	Discard plants immediately. Next time, direct sow, or follow procedures in chapter 2 for correct pricking out.
Roots coiled at the bottom of the bag	Cut roots with machete or pruners before planting. Remove plants in good time from the nursery. Use root trainers (see chapter 4).
Roots penetrating into the soil beneath bags	Lift bags and prune roots frequently. Remove the plants in good time from the nursery. Use root trainers on frames above the ground (see chapter 4).
Multiple plants per bag	Remove extra seedlings early, before they become very big.
Plants with multiple stems	Discard — the cause may be poor genetic quality.
Diseases or insects	Isolate or burn any affected plants. Develop a plan for pest management.
Yellow or white leaves, or leaves with dark green or purple veins and light spots in between	Fertilize plants or use a richer substrate (see chapters 3 and 7).
Large variation in plant sizes among plants sown at the same time	Check for patterns within the beds and throughout the nursery that can be associated with uneven shade or watering.
Plants grow slowly	Adjust light (try more or less), fertilize, or use a better substrate (see chapters 3,6 and 7).

Regularly survey seedling quality to correct problems through appropriate nursery management.

Keep the best, ditch the rest

In every population of trees, there will always be some plants of good quality and some of bad quality. On average, 20–30% (and often even 50%) of the trees will be of poor quality. Thus, the nursery should always produce 20–30% more plants than needed to meet a given target. Nursery managers must accept that it is quite normal to throw away plants. Unfortunately, many do not. Many people do not want

to see their hard work thrown away, or they believe that the plants still might have a chance. These ideas are false.

Discard poor quality trees as soon as you detect them.

A ***good nursery practice*** is to discard poor quality trees as soon as you detect them. They waste space and resources in the nursery, and can be a source of infection. The process of removing poor quality seedlings is known as 'culling'. It is a greater waste of hard work and money to maintain trees of poor quality in the nursery and in the field, than to throw away poor quality trees in the nursery.

Variable plant growth in the nursery is carried over to the field. A weak plant will never catch up with others that were strong when planted out. A ***poor, but unfortunately common, nursery practice*** is to select the best trees for planting, but then leave the bad ones in the nursery. These are then given to the next unsuspecting customer. This is very unfair to your customers. Only the best quality trees should leave the nursery, the others should be thrown away at that very moment. A plant that is not considered good quality does not suddenly become better when the best ones have been planted.

Another ***poor, but unfortunately common, nursery practice*** is to leave plants in the nursery from one production year to another. These are usually the left-over plants that no one wanted. By the next planting season they are overgrown and have severe root deformities. If plants grow very slowly during the year and remain in the nursery more than one season, throw these ones out, and try adding more compost to your substrate, or allowing your plants more sun.

Summary of seedling quality

Seedling quality is governed by two factors: the genetic make-up of the parent trees, and the physical growth of the seedling. Good nursery management can make the best use of these to greatly improve the growth and survival of seedlings. Your nursery customer deserves only the best quality seedlings.

Good nursery practices

- consult farmers as well as forestry technicians when selecting the seed sources for the nursery
- select the parent trees well in advance and design a strategy to ensure sufficient seed is collected
- collect seed from at least 30 parent trees
- judge seedling quality by several traits
- conduct regular surveys of plant quality
- sacrifice a few plants to improve total nursery production quality
- use plant quality surveys to correct problems through appropriate nursery practices
- discard poor quality trees as soon as you detect them

Poor, but unfortunately common nursery practices

- collecting seed from only a few trees close to the nursery
- selecting the best seedlings for planting out, and delivering the bad plants to the next customer rather than throwing them away
- leaving plants in the nursery from one production year to another