



MANAGEMENT GUIDELINES

**FOR VALUABLE WOOD PRODUCTION IN
AGROFORESTRY SYSTEMS**

Imprint

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This management guideline provides information about how to produce valuable timber outside of forests – for example on agricultural land.

Such an “Agroforestry” approach provides an opportunity to utilise the full potential of agricultural land both economically and ecologically.

However, well-shaped trees for the timber industry don’t grow by themselves. They need to be cared for in the early years after their planting. This guideline explains what is important for the successful planting, management and harvest of valuable timber trees.

While focusing on practical aspects, it addresses occupational groups such as:

- Farmers
- Landowners
- Foresters
- Forestry consultants / planners / advisors



WHAT IS AGROFORESTRY?

"Agroforestry is a collective name for land-use systems and practices where woody perennials are deliberately integrated with crops and/or animals on the same land management unit. The integration can be either in spatial mixture or temporal sequence. There are normally both ecological and economic interactions between the woody and non-woody components in agroforestry."

International Centre for Research in Agroforestry (ICRAF)

The term agroforestry is a combination derived from its constituent parts: the words agriculture and forestry.

Agroforestry is characterised by two components: trees with crops or trees with animals. The trees (or shrubs) can be included in the agroforestry area or surround it.

Trees act as one of the two vital components within agroforestry systems. The presence of trees on farmed land increases the ecological and aesthetical value of the landscape, and they also have an important economic value for the farmer.

To meet these demands and to combine ecological with economic advantages, the solution could be to integrate the production of trees for valuable timber with regular farming activities, within well designed agroforestry systems.

Most agroforestry systems are based on planting trees in continuous or discontinuous rows with alleys in between the rows of trees, for the farming activity. Another option is to plant the timber trees along the borders of fields, this leaves a completely open space for farming.



TYPES OF AGROFORESTRY SYSTEM

There are currently **six** main types of Agroforestry system:

1. Forest Farming Systems

Trees specifically grown to provide shade for understory commodity crops



2. Windbreak Systems

Trees around fields.



3. Silvopastoral Systems

Trees, animals and pasture.



4. Integrated Riparian Management Systems

Trees on stream/riverbanks

5. Intercropping Systems

Trees and crops.

6. Bioenergy systems

Trees and short rotation coppice as a 'crop' for energy.

There are several different types of agroforestry systems available to the landowner as no one particular system suits every farm. This allows for greater flexibility in agroforestry and ultimately optimal use of agricultural land.

WHY CHOOSE AGROFORESTRY?

This land use system which allows the production of valuable trees in combination with a regular farm activity offers a multitude of benefits to the landowner.

Agroforestry can:

- Diversify the income sources (reduce the risk of fluctuating agricultural markets).
- Generate wood products
 - Sawlogs for lumber.
 - High-value timber for veneer logs.
 - Produce fuel-wood for heat or energy generation.
 - Introduce fruits and nuts and other non-wood forest products into the landscape.
- Enhance overall farm productivity with associated environmental benefits.
 - Provide ecological advantages (increased biodiversity and habitat creation).
 - Facilitate a more efficient capture and utilisation of all available solar radiation and carbon fixation per hectare.
 - Reduce soil erosion by wind and water.
 - increase carbon storage potential in the trees to decrease or offset the farm's carbon footprint.
 - Gain advantages for annual crops (nutrients can be raised to the surface layers of soil by the roots of the trees from deep soil layers and are recycled in the system via the leaf litter layer).
 - Reduce insect pests by encouraging more natural predators such as birds and insect predators.



For a farmer who adopts an agroforestry system, a long term outlook is required, the tree component can remain in situ for more than 50 years.

Not every tree planted will achieve the highest prices on the timber market, therefore it is essential to consider the most important factors during the planning stage. Solid planning will help reduce or prevent problems in later developmental stages of the system. By choosing the right tree species (or set of species) that is most suited for your site and planning a suitable layout, you gain maximum benefits from your system.



WHAT KIND OF WOOD IS VALUABLE, AND WHICH TREE SPECIES SHOULD I USE?



All timber has some value but the highest market prices are most often obtained for those logs which are suitable for the veneer industry. Producing high quality logs that are suitable for veneer and high quality furniture is challenging and is strongly dependent on three points, all of which you can influence to gain the best return on your investment:

- **Species**
- **Quality** (knot free straight grained wood, no 'shake')
- **Dimension** (log length, diameter and volume)

You can achieve the highest prices in average using selected valuable broadleaf species. Generally, broadleaf species are the most valuable and they also cast the least shade. The most common ones are:

- Cherries (*Prunus* spp.)
- Walnuts (*Juglans* spp.)
- Maples (*Acer* spp.)
- Alders (*Alnus* spp.)
- Sorbus species (*Sorbus* spp.)
- Ashes (*Fraxinus* spp.) However, planting ash is not recommended at present due to Ash dieback disease (*Hymenoscyphus fraxineus*)!

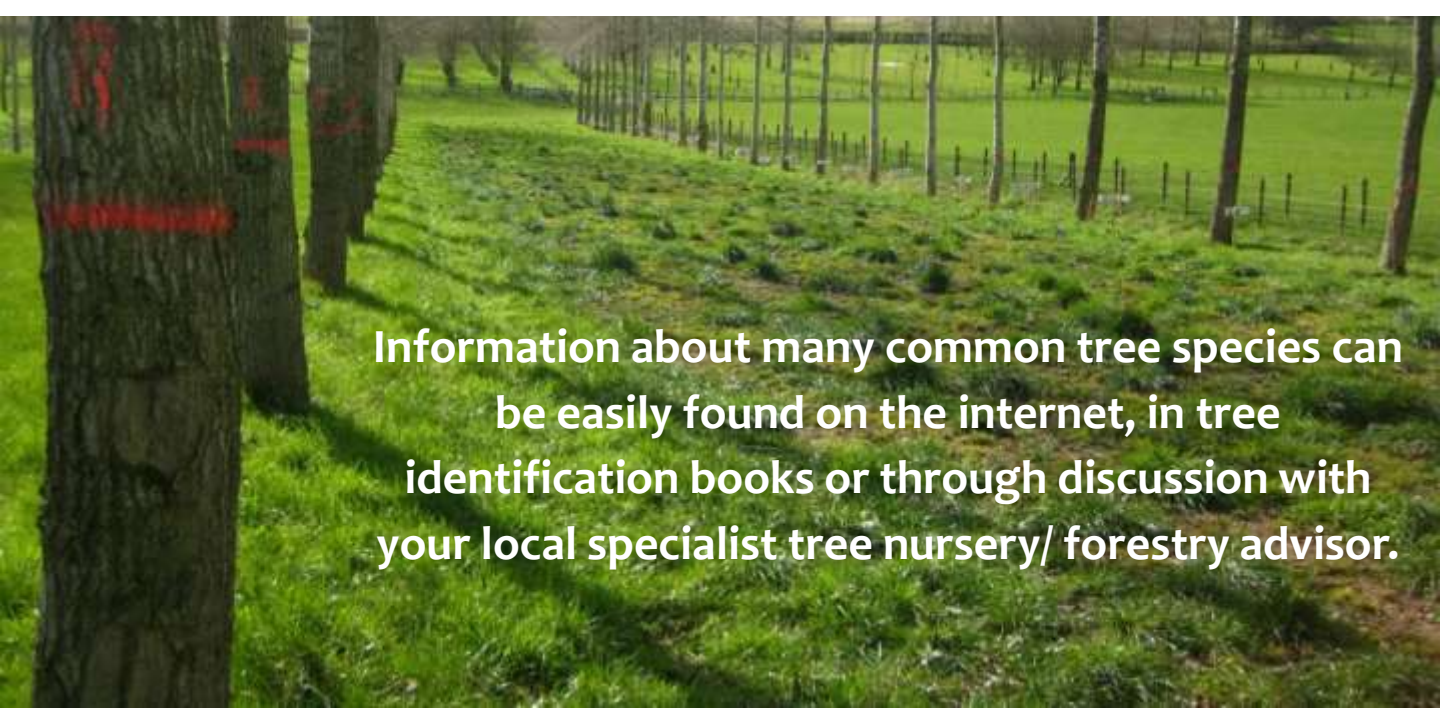
It is always best to establish a mixture of species within one site. This allows a degree of buffering against unforeseen consequences such as pests and diseases, against market fluctuations, and more frequent weather extremes caused by climate change.

CAN I GROW ANY TREE SPECIES ON MY LAND?

Not all trees will grow successfully on every site. Before deciding to establish any particular species it is imperative to gain some knowledge about your site in relation to its suitability for various species so as to avoid failure of the trees. Check in your local area and identify which species are growing naturally.

The most important site characteristics influencing the choice of tree species are:

- Soil type
- Temperature
- Precipitation (amount and annual distribution)
- Water regime (water table, water holding capacity, stagnancy of soil moisture)
- Risk of early or late frost events (may kill the leading shoots)
- Soil-aeration
- Soil nutrient content



Information about many common tree species can be easily found on the internet, in tree identification books or through discussion with your local specialist tree nursery/ forestry advisor.

HOW SHOULD I CHOOSE MY PLANTING MATERIAL?

Criteria to consider:

- Adjusted provenance¹
- The genetic quality of the planting stock (choose sources of saplings which are in the highest genetic grade² that is available)
- The vitality of the trees (stem and root mass)
- Saplings which display a good early stem form

Since valuable sawn wood is only produced from high quality timber logs, it is critical to use saplings which are well adapted for growing in your region. Using the correct provenance¹ of the tree saplings is of great importance for the success of the system, as is using plants of the highest genetic quality available. Furthermore, one should plant only high quality vital saplings from the nursery, i.e. saplings with a good balance of shoot to root mass, the absence of disease lesions or injury on stems, straight stems and an absence of forks. Roots should not be damaged, distorted or kinked, and a high amount of fine roots should be present.

We suggest to plant trees with a height over 1.5m to minimise any competition for light and weeds, to impede game browsing, and to facilitate management. Potted trees show better growth, especially directly after planting, but are more expensive than bare rooted trees.

If you plant bare rooted trees take care: the roots must never be allowed to dry out!



¹PROVENANCE

An individual tree which is locally adapted to the area or site. It is for example not recommended to plant lowland derived seeds or saplings on a highland site.

²PLANTING MATERIAL

All forest plants which are on the market are classified into 4 grades based on genetic quality, according to EU Directive 1999/105EC). The highest grade is 'Tested' the next best grade is 'Qualified', then 'Selected'. The lowest genetic grade is 'Source Identified'. The most common grade available is 'Source Identified', in this case the region of provenance in which the seeds were collected is known but no selection was made on the parent trees which provided the seeds. The next genetic grade is 'Selected': this means that seeds were collected in stands of trees which displayed superior qualities in stem form and growth. Saplings may also be available on the market in the category 'Qualified': saplings in this category are generally derived from seed orchards in which the parent trees had been selected for superior traits. The highest genetic grade is 'Tested': in this case results are known for the performance of the material from scientific trials; some cherry varieties are available in this category.

A low-angle photograph of a tall, slender tree with a thick trunk and a complex network of bare branches reaching towards a sky filled with soft, white clouds. The tree's trunk is dark and textured, while the branches are thin and intricate. The sky is a mix of light blue and white, with the clouds appearing as soft, billowy shapes.

WHERE CAN I GET TREES TO PLANT?

Trees should be bought from a reputable tree nursery.

Here you will be able to obtain high quality trees with known growth characteristics, and a suitable provenance which will display vigorous growth once planted.

You can find such nurseries on the internet or by asking a forester.

HOW FAR SHOULD THE TREES BE AWAY FROM EACH OTHER?

After you have made a choice regarding your species mixture, you need to carefully plan the planting design, because the system cannot be easily changed afterwards. Most importantly, you need to decide upon the overall density of maturing trees in your agroforestry system. A commonly made mistake is to plant trees too close together so that the crowns cannot develop to their full potential, to intercept all of the available photosynthetic light. Based on the fact that there is a strong relationship between trees with big crowns and trees with big stem diameters, for all species, you can easily calculate the **final** distance between your future crop trees¹. If you plan to produce a tree with a target diameter of 60cm (at a height of 1.3m above ground i.e. dbh); the distance which should be allowed between the trees can be calculated in the example as follows:

Distance between the trees = Target diameter x 25

Example: 60cm x 25 = 1500cm (15m)

In our example, each tree would have a minimum distance to each neighbour of 15m in all directions. This results in a density of 44 final crop trees per hectare.

Similar calculations for various target diameters of the final crop trees are illustrated below:

Target tree diameter at breast height (dbh) [cm]	Minimum inter- trees spacing of the final crop trees [m]	Number of final crop trees per hectare
60	15.00	44
55	13.75	53
50	12.50	64
45	11.25	79

At the end of the rotation the crowns of two trees with the calculated spacing would nearly touch each other. If you consider this to be too much shading for the intercrop, just increase the distance between the trees. Moreover, the distance between trees should also suit the machinery you plan to use on the site.

¹See also Spiecker & Spiecker 1988: Erziehung von Kirschenwertholz (Production of valuable cherry wood). AFZ (20), pp. 562-565 (in German)

SHOULD I PLANT ONE TREE OR LITTLE GROUPS?

Since it is always possible that single trees do not develop as desired. Therefore we recommend planting a group of two or three trees within rows with approximately 1.5- 2 metres between each tree. None of the trees in each group should be closer than 15 m to any tree in the next adjacent group (see example above). When the competition within these groups becomes too great (growth will slow down and poor stem forms will be seen), you can then choose the best performing tree within the small group, in terms of growth form and vitality. Using this approach, you can reduce the risks of maldevelopment of single trees at a given spot in the tree row. In principle, agroforestry systems are very flexible in establishment options. However, grant aided schemes may specify different conditions to those proposed above and should be consulted.

Flexibility in implementation means that, you do not have to plant all the trees in the first year, but can plant some trees each year! This spreads the investment costs and reduces the workload within one year.

Moreover, you can also spread the harvest of the trees across a number of years because they will reach their target diameter at different times.

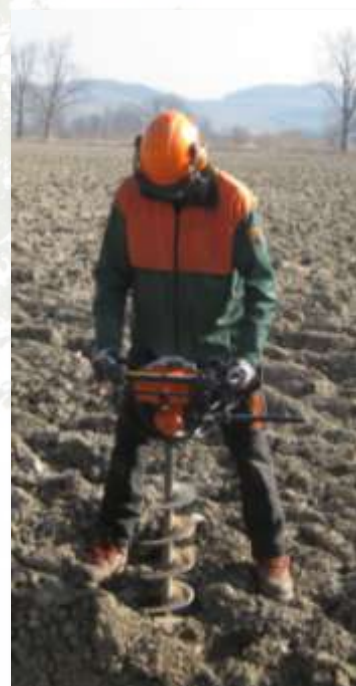


WHEN CAN I HARVEST THESE TREES?

The growth of trees just as for other plants is dependent on the soil, climatic conditions, the tree species, and even the tree individual. Hence, you cannot accurately predict how long it will take to reach your specified target diameter. Nevertheless, on good soils, the diameter of a tree can increase by 1cm per year. In this case, of course, the target diameter of 60cm is reached after about 60 years.

PLANTING

When planting, a few tips will maximise your success. For large numbers of trees you may wish to use machinery to help, for low numbers a spade and shovel will suffice. Careful planting is essential and aftercare is also important to make sure that your efforts in planning and planting result in a valuable mature tree.



WHAT TOOLS DO I NEED TO PLANT A TREE?

Planting tools: Shovel, spade, auger, sledgehammer/post driver

Materials: Tree, stake, tree guard, tree tie

Personal Protective Equipment: Boots, eye protection
and ear defenders (for work with auger)



Begin by digging a hole using a spade and shovel or a mechanical auger. Heap the resulting earth neatly to one side. The hole needs to be a bit bigger than the existing root system. If the soil is very dense, avoid creating walls that keep the water inside by making some cuts in the walls of the hole with the spade. A square hole can prevent the tree from becoming root bound, which will limit growth. Digging a square hole (or auguring out a round hole and squaring it up with a spade) will encourage roots to venture into the surrounding soil once they hit a corner.

WHEN IS THE BEST TIME TO PLANT?

It is best to plant when the conditions are right for the young saplings:

- During autumn or early spring
- In unfrozen ground
- When the ground is sufficiently wet and/or when a wet period is forecast
- After ground vegetation is cleared (herbicide or mechanical)

Take good care that the roots of the saplings never become dry. Place the tree into the hole and spread out the roots evenly in the planting hole to avoid buckled roots which will negatively influence tree growth. If you use a stake (see the next paragraph), carefully hammer it into the hole and try to avoid injuring the roots of your new tree.

Refill the hole with earth and carefully compress with the heel of your boot while holding the tree with one hand in an upright position. In some areas with lots of mice and voles it can be necessary to use a steel mesh such as chicken wire to protect the roots in the first years after planting. Ideally this mesh should not be galvanized to allow the root ball to grow as the mesh deteriorates. To protect the roots with this metal net, cut a square piece with a side length of about 1m, place it into the hole, put the tree in it, add earth around its roots, and close the wire net around the root system (see photographs below). Then fill the rest of the hole with earth, and, if possible, water the tree.





SHOULD I STAKE MY TREES?

Yes! The primary task of a stake is to provide support for the newly planted tree. Alternatively a tree tube may provide a similar support for the early years of growth.

The stake should be positioned perpendicular to the prevailing wind with the tree behind. In this way a small amount of tree movement is possible (good for strong root development) and the tree does not knock into the stake causing damage to the bark.

The tree can be tied to the stake using a rubber tree tie. It is important however, not to tie a tree too tightly or you will damage the bark as it grows, effectively strangling the tree! Don't forget to check the tie periodically and remove or re-tie it when it gets too tight.

The position of the tie is also important: if positioned too low the stake provides no support, too high the stake provides too much support and the root ball does not develop sufficiently to support the tree.

The stake will also act as a marker, you will be able to see where you have planted your trees when you come to manage the area.

SHOULD I PROTECT MY TREES AGAINST ANIMALS?

If animals are present you must protect your trees! If the field is fenced and free of large animals you do not need additional protection. If the site is not yet fenced a number of options are available:

OPTION 1: Use a plastic (often semi-biodegradable) tree shelter tube, these are available in various sizes and are especially useful to protect against browsing animals such as hare, rabbits and deer. They may also provide some protection against sun scorch to the lower parts of stems which are fully exposed to the sun. However, avoid using shelter tubes that have a sharp edge at the top end and those with large ventilation holes.



The sharp edges can cause damage to the bark. Deer can remove tubes with large ventilation holes by sticking their antlers into the holes and tearing on it. Shelter tubes which proved most suitable in tests were those made of soft materials with splayed top edges and small ventilation holes (see picture above).



OPTION 2: If the field is grazed by livestock, a more robust guard will be needed, this can be constructed from timber with three or four posts joined by rails - it must be robust enough to support the weight of a cow with an itch! If hare or rabbits are present, you can easily add a metal / plastic mesh or spiral covering to the lower part of the tree with the lower end partially buried into the ground.



Electric fences may also be considered for excluding large animals from tree rows. For continued protection against browsing damage, it is also essential to ensure that protective measures such as fences or tree guards remain in good order for a number of years post planting. Try and check these measures a several times a year when inspecting the agricultural component of the system.



HOW SHOULD I CARE FOR THE TREES AFTER PLANTING?

During the first years, comprehensive aftercare is crucial for the survival and vitality of the established trees.

WEED CONTROL

Weeds, especially grass are strong competitors for the young trees in the establishment phase. Hence, you need to reduce the weed growth around them, especially during the first and most important year. In the following years, careful weed control helps to reduce competition and thereby, increases the rate of growth of the trees. The removal of grass cover will also help reduce rodent damages.

There are three different options for the control of weeds: chemical, physical, and mechanical. The most efficient way to suppress weed growth is to use herbicides. However, it is also the least ecological approach. Should you decide to use an alternative approach, you need to carefully monitor the weed status

within your plantation. During the establishment year, the application of a mulch material is very helpful. You can use composed woodchips, straw, old hay, or cut grass as a mulch material. But also artificial materials such as self-decomposing mulch-mats made of corn starch, jute twine, or fibre board can help to reduce weeds around the trees. If you apply mulch treatments, you can reduce the application of herbicides.

Furthermore, to avoid the use of herbicides in the first years after planting, mechanical weed control using brush cutters, mowers or rotivators is an effective way to support the tree's growth. However, great care is needed to avoid any damage to the tree.

SUPPRESSIVE WEED CONTROL

Mechanical: Brushcutter, strimmer, flail mower or mulcher

PREVENTATIVE WEED CONTROL

Mechanical: Rotivation, cultivation (tillage)

Physical: Mulch mats, wood chips ...

Chemical: Herbicides: Where grass dominates a graminicide should be used pre-planting and thereafter. General contact herbicides may be appropriate during the summer growing season and residual herbicides for winter application. Avoid any contact with the tree.

REPLANTING (BEAT-UP PLANTING)

It may be necessary to replace trees that have died in the first year following planting. Try to determine the cause of death:

- Plant quality
- Water supply: Too dry or too wet
- Pest
- Disease

Also it may be necessary to reconsider the species choice in these cases so a more appropriate species can be chosen for replanting.



WATERING

Intensive watering is needed during dry periods in the first establishment year.

FERTILISATION

Generally, the addition of fertilizer is not essential to establish trees. However, if you think the application of a fertilizer would be helpful, chose a brand with a slow release form.



WHY DO I NEED TO PRUNE MY TREES?

Pruning is the removal of either live (green) or dead branches from the main stem to produce a branch free bole of valuable timber.

Pruning is an crucial step required for the production of valuable timber during the first 15 years of tree growth.

This forms the most labour intensive part of plantation management.

The goal of pruning is to achieve a branch-free bole length of at least 3m.

Pruning provides the following benefits:

- Increased valuable timber volume by producing a branch-free bole with knots confined to a small knotty core
- Improved tree form by removing forks (“Formative pruning”)
- Reduced hindrance for the machinery used for the management of the crop / pasture areas by increasing the insertion height of the lowest branch (i.e., raising the crown)
- Improved aesthetic appearance of the landscape



WHEN SHOULD I PRUNE?

Inspection of trees in the first and second year after planting will indicate the need for pruning. Rapidly growing trees with many heavy side branches will benefit from early pruning. Generally there may be a need to initiate the first pruning after two to three years of growth. This is dependent on the growth of the tree: in the case of a vigorous species such as wild cherry it may be needed after the second year of growth. As every pruning intervention results in a temporary weakening of the tree, diameter growth is reduced for a period after the pruning. With this in mind you can opt to prune your trees less intensively (i.e. remove less branches each time) but more frequently or apply a less frequent but more intensive routine.

Continue with pruning the trees in consecutive years until you have reached the desired branch free bole length. Afterwards you only need to intervene if epicormic shoots occur.

Pruning can be carried out in late winter, but for most trees, the growing season is the better choice, since the wounds close faster. Some species should ideally be pruned in summer (e.g. cherry: early summer; walnut: middle of summer) as there is less risk from fungal infections at these times.

Important: Avoid pruning during periods of very low temperature or severe droughts!





Sometimes, the terminal shoot of a tree dies. Pruning therefore was to choose the steepest growing branch (arrow) to replace the leader (and removing all competing branches at that stem level). In time, as the stem grows larger, it will assume a straight shape again.

Epicormic shoots are also known as “suckers” or “water sprouts”, these are branches / shoots emerging from dormant buds underneath the bark on the main stem.

It is necessary to remove epicormic shoots since they will also reduce the quality of the wood. At an early stage, you can easily remove epicormic shoots by hand.



SHOULD I PRUNE ALL TREES?

It is only beneficial to prune those trees which have the potential to become future crop trees (trees with a clear potential to produce timber with suitable dimensions i.e. length and diameter). Otherwise, it would be a waste of resources (time and money). The trees to be pruned can be selected by the following criteria:

High vigour: only trees with an above average DBH, height and a large crown size.

High timber quality: a straight unforked stem with no damage, plus with few branches on the lower stem.

WHAT TOOLS DO I NEED TO PRUNE A TREE?

PRUNING TOOLS: Pruning saw, secateurs, loppers, telescopic or pole pruner/saw, ladder

PERSONAL PROTECTIVE EQUIPMENT: Gloves, eye protection, hard hat (Harness: if vertical sectional ladder systems are used)



Smaller diameter branches can be pruned using **secateurs**. These create a clean cut which heals quickly.

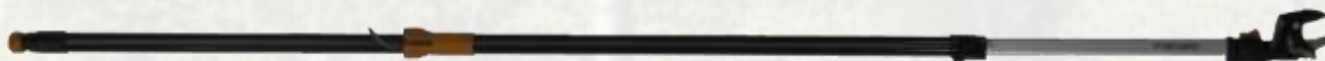


Larger diameter branches can be cut using a **pruning saw**.

Specialist pruning saws are available which only cut in the 'pulling' direction. They are thin and very sharp.



Loppers can also be used on branches no thicker than your thumb.



Branches which are out of reach from the ground can be cut using a **pole/telescopic pruner** with a saw or shears, this allows for a clean cut. However, you need to use it with caution since it is easy to misplace a cut and/or cause the bark to rip. You also need to take care from falling branches – wear a hard hat.

You can use a ladder to prune high branches. A free standing step ladder is useful on firm level ground, more preferable is a leaning ladder that you can lash to the tree when working. Better still is a sectional ladder system that is fastened to the tree trunk and allows the climber to ascend vertically to the tree crown. This system requires a harness and should not be used without prior tuition.



Tree before pruning



Tree during pruning with worker on sectional ladder system



Tree after pruning



HOW HIGH SHOULD I PRUNE?

The final height of obtainable timber depends on the final height that is possible for that tree species in the local environment. During pruning you should not remove more than one third of the overall volume of the living crown.

The final pruned trunk should not be more than $\frac{1}{4}$ to $\frac{1}{3}$ of final total tree height.

HOW SHOULD I PRUNE A TREE?

- A smooth cut which results in the smallest exposed area increases the speed of wound closure! (Fig. 1)
- Avoid ripping the bark! Remove bigger branches by applying additional relief cuts (Figs 1 & 2: RC1 and RC2 before the final cut).
- Try to keep the branch stubs as short as possible!
- Avoid flush-cuts and stub-cuts (see red lines in figures below).

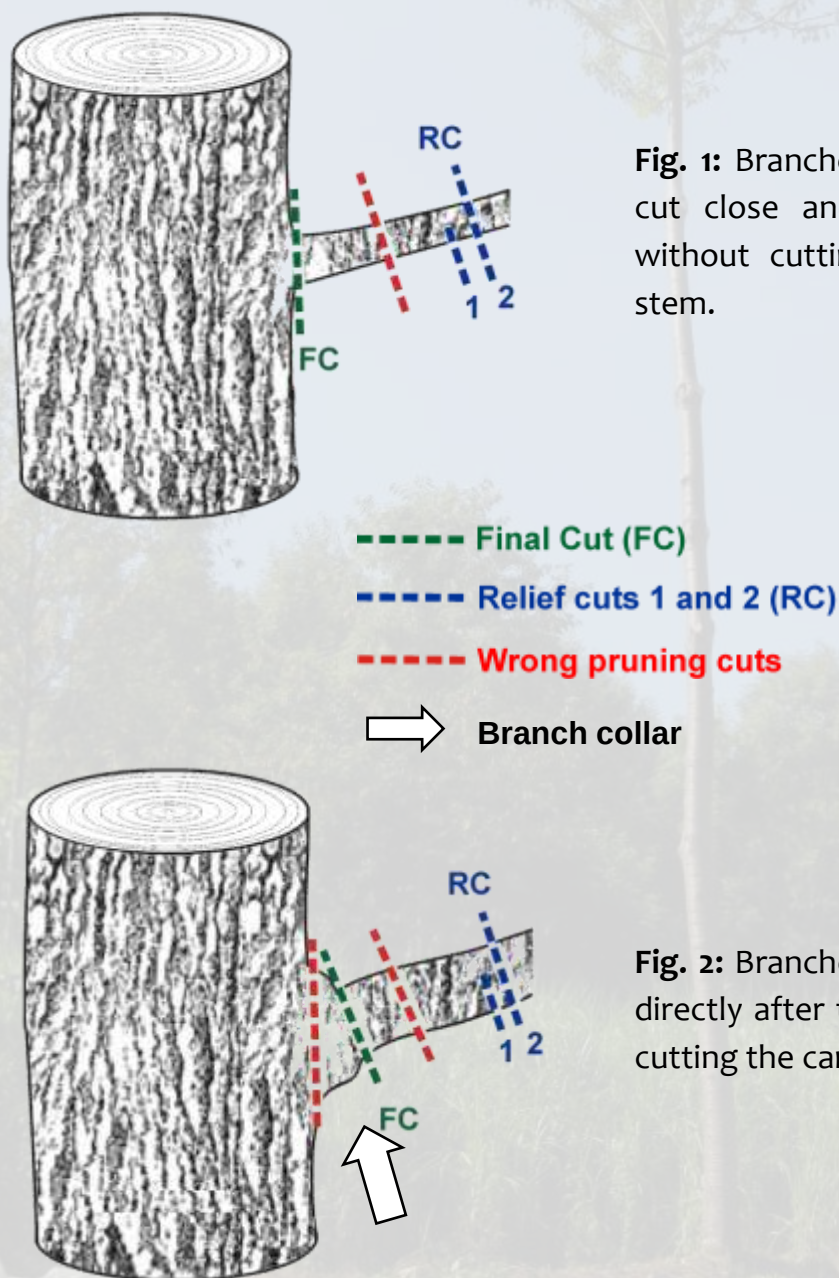


Fig. 1: Branches without branch collar: cut close and parallel to the trunk without cutting the cambium of the stem.

Fig. 2: Branches with branch collar: cut directly after the branch collar without cutting the cambium of the stem.



Relief cuts not made: branch tears bark, creating a large unsightly wound.



Relief cuts not made: branch tears, creating a cut face that is not smooth an entry point for damaging fungi.



Left side of the stem (white arrow) a correctly pruned branch.

Right side of the stem (red arrow) a protruding branch stub which will take a long time to occlude and will create what is known as a dead knot (which will devalue the price of resultant timber).



A large pruning wound which is slow to occlude.

Occlude/Occlusion: Describing the action of a tree growing tissue over a wound until it is fully closed

SHOULD CUT SURFACES BE TREATED WITH WOUND SEALANT?

Although a number of wound sealant products are available, it is not necessary to treat the cut surfaces with such products because they may, in fact seal in damaging agents such as bacteria and fungi. If pruning is carried out correctly, and sufficiently early when the wounds are small, the wounds will quickly close naturally (occlude) with new tissue growth.

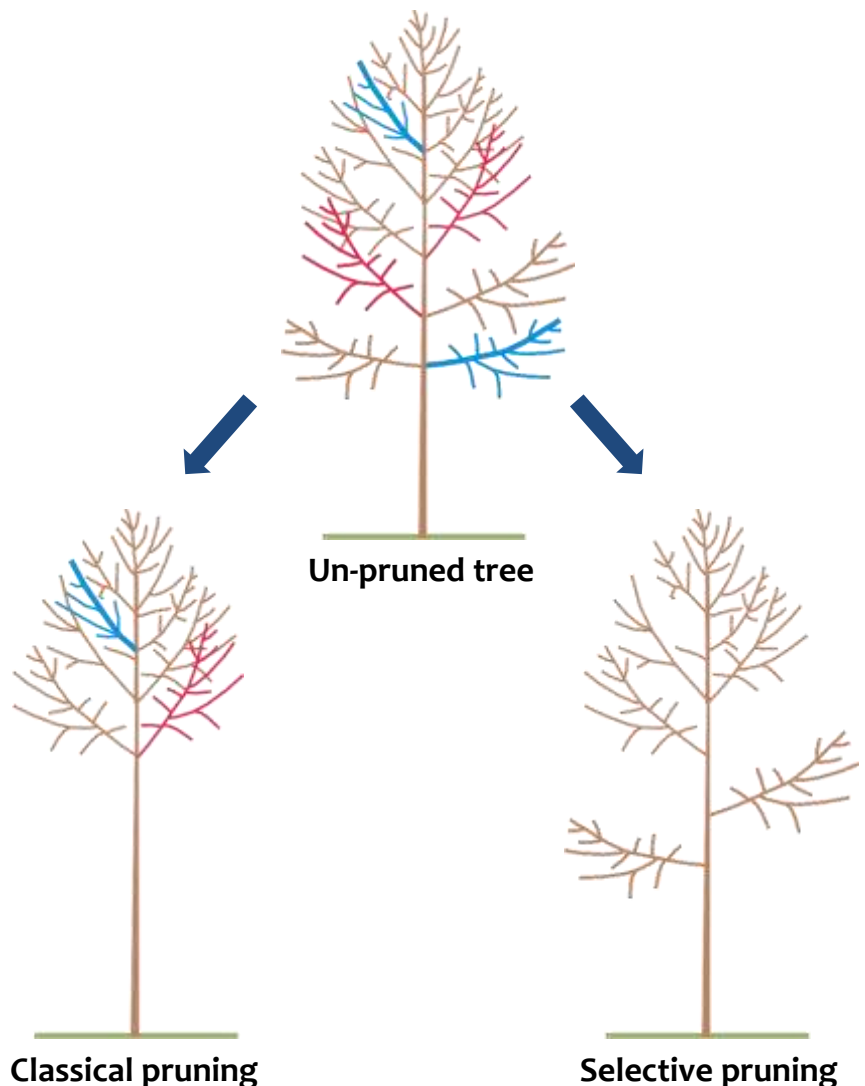
TWO TECHNIQUES TO PRUNE A TREE: CLASSICAL VS. SELECTIVE PRUNING

In general there are two different approaches on how to best prune a tree. The most common and easier technique is **classical pruning**. Using this approach all branches from the bottom up to a certain height will be removed in a stepwise fashion.

The second technique is **selective pruning**. In this latter case, selected branches that exceed a certain diameter (for example 3cm) are removed (shown in **blue** in the diagram below). Also, branches which grow at steep angles to the vertical are strong competitors for growth with the main shoot so they should be removed within the whole tree (for example steeper than 40° , shown in **red** in the diagram below).

This more time consuming technique removes the thick and steeply angled branches that reduce wood quality early in the tree's development while the remaining branches continue to contribute towards photosynthesis at the same time suppressing the growth of epicormic branches. Within the last pruning treatment all branches up to a defined height will be removed.

At the end the final result is the same for both techniques, but the way to get there is different!



	CLASSICAL PRUNING	SELECTIVE PRUNING
PROS	• Fast, and efficient • Easy to explain	• Avoids large / huge pruning scars • Keeps self-shading for the stem • Reduces epicormic shoots
CONS	• More vital epicormic shoots • Increased danger of sun damage	• More time consuming and therefore expensive to carry out • More complex



5. HARVEST OF THE FINAL CROP TREES

**IMPORTANT:**

Felling operations should not be performed without intensive training and without permission from the relevant authorities!

Consider hiring a proficient and reputable contractor. This guideline contains no guidance on felling trees, only recommendations regarding the planning of the harvest and the processes that must be undertaken at this final stage.

WHAT TOOLS DO I NEED TO HARVEST A TREE?

Tools: Chainsaw, felling equipment (axe, wedges, ...), tractor, (Harvester)

Personal Protective Equipment: Hard hat incl. visor and ear defenders, Chainsaw protective trousers, Chainsaw boots, Gloves, High visibility clothing (if large machinery is on site).

When your trees have reached the final target diameter, you can consider harvesting them to release their value. You can decide if you want to harvest them all at once or sequentially over a number of years. However, because it is easier and more profitable to sell your timber as whole timber truck loads, discuss with your local sawmill what their minimum requirements would be.

WHAT SHOULD I CONSIDER WHEN PLANNING THE HARVEST OPERATIONS?

- Extraction routes,
- Location of timber stacks, If the timber is to be collected from the roadside,
- Signage/ diversions if the public have access to the site,
- Sawmill requirements (stem length units; top/bottom diameter etc.),
- Where to fell the trees (into fields: therefore the crops / animals must be absent)?
- How will the timber be moved (skidded/forwarded)?

WHEN SHOULD I HARVEST THE TREES?

The harvest is usually carried out when the trees are near or at maturity in dimension and when market prices are attractive.

The most favourable time period is during winter as:

- The ground is often frozen, this reduces damage and provides easier access
- Bird nesting season has not started (check local wildlife laws/guidelines)
- Often: Absence of intercrop

After the harvest, you can already substitute the felled trees with new ones!

WHAT SHOULD I DO WITH THE BRASH?

After snedding the felled trees (branch removal from the stem) and the removal of the logs all the branches will be left in the field

- Pile them beside the field
 - Biodiversity benefits
 - Simplest method, but piles might get in the way of other management operations
- Chip it and compost it for mulch (as long as the brash don't get too dirty, the presence of mud and stones mixed into the brash will blunt chipper knives)
- Chip it for biomass (volume dependent)
- Larger diameter branches can be used for domestic firewood



PLAN OF MANAGEMENT OPERATIONS WITHIN THE YEAR

This overview should help you to plan the most important management operations.

[illegible]

TYPICAL COSTS AND BENEFITS FROM PRODUCING VALUABLE TIMBER TREES

Returns on investment are heavily dependent on the country and region you live in. Furthermore, supply and demand fluctuations have a direct effect on the market value of produced timber.

In addition to fluctuating market situations towards the prices of high value timber it is impossible to accurately predict the return provided after a production time of 50 or more years.

In summary, the size of the return on investment is dependent on:

- Country
- Region
- Market situation
- Species, driven by current trends (i.e. demand)
- Diameter of the tree or log
- Quality of the log sold
- Amount of timber that you sell

Nevertheless, to provide guidance an example is given on the following page outlining possible costs and returns for the production of valuable timber.

EXAMPLE

All values are taken from Germany. The following two tables provide an approximate idea of the arising costs and returns.

Table 1 contains a list of all necessary management operations, the approximate time needed to perform them, and the costs that can be assigned to them. In practice many practitioners won't calculate the time spent on individual tasks, nor calculate costs with a given interest rate over a 60 year rotation. However, the figures in Table 1 provide an idea of what to expect *if* every management task is included, based on the planting and management of **a single tree**.

	Year of growth	Activity / material	Working time (man minutes) [min]	Incurring costs	
				Costs excl. interest [€]	Costs inkl. 2 % interest [€]
Planting	0	Plant material	15	5.0	16.4
		Motor manual soil driller		2.0	6.6
		Tree shelter		3.5	11.5
		Working time for planting		7.5	24.6
Maintenance	1	Weeding	5	2.5	8.0
	2	Weeding	5	2.5	7.9
	3	Weeding	5	2.5	7.7
	3	1. Pruning	5	2.5	7.7
	6	2. Pruning	10	5.0	14.6
	8	3. Pruning	15	7.5	21.0
	10	4. Pruning	15	7.5	20.2
Harvest	60	Chainsaw (5.5-6 € / h)	120	12.0	12.0
		Tractor (15 € / h)		30.0	30.0
		Working time for harvest		60.0	60.0
Totals	Working time		195	97.5	171.7
	Material			52.5	76.5
	Total costs			150.0	248.2

Table 2 shows what you can expect in return in this scenario calculated again per valuable timber tree.

Proceeds from valuable timber (1.4 m³ and 400 € / m³)	560.00 €
Proceeds from fire wood (4.4 m³ and 30 € / m³)	+ 132.00 €
Total proceeds (valuable timber + fire wood)	692.00 €
Total production costs	-248.20 €
Net profit per tree	443.80 €

**SAFETY NOTE: MACHINERY**

the use of machinery should not be attempted without adequate training and where relevant, certificates of competence. Please seek guidance from your local health and safety governing body for more information.

**SAFETY NOTE: LADDERS**

The use of ladders should not be attempted without adequate instruction. Avoid work at height where it is reasonably practicable to do so. Do not overload or overreach when working at height. Where possible and applicable use a certified fall arrest system. Ensure equipment is suitable, stable and strong enough for the job, maintained and checked regularly. Please seek guidance from your local health and safety governing body for more information.

**SAFETY NOTE: PESTICIDES**

The use of pesticides should not be attempted without adequate training and where relevant, certificates of competence. Please seek guidance from your local health and safety governing body for more information.

**DANGEROUS FOR THE ENVIRONMENT:**

Use pesticides only according to the directions on the label. Follow all directions, precautions, and restrictions that are listed. Do not use pesticides on plants or sites that are not listed on the label. The USER is always responsible for the effects of pesticide residues, as well as for problems that could arise from drift or movement of the pesticides from his property to that of others.

WEBSITES/ADDRESSES/USEFUL INFORMATION

- Chair of Forest Growth (University of Freiburg): <http://www.iww.uni-freiburg.de/>
- Agroforestry research at the chair of Forest Growth: <http://www.agroforestry.de>
- EU- AGROCOP- project: <http://www.agrocop.com>
- European Agroforestry Federation: <http://www.agroforestry.eu/>

Links to national / regional grant schemes which support AFS establishment:

- Ireland:
<http://www.agriculture.gov.ie/media/migration/forestry/grantandpremiumschemes/2015/AfforestationSchemeEd2190315.pdf> (see page 27)



PHOTO CREDITS

- Christopher Morhart (all photographs unless stated below)
- Jonathan Sheppard (Pages: 1; 15 right; 19; 20; 22 3x right; 24 bottom; 26 all 4 in foreground; 28)
- Michael Nahm (Pages: 3 middle; 12 left; 13 bottom; 22 left)
- Heinrich Spiecker (page 16 right)

