Plant & Food Research
Rangahau Ahumāra Kai

Kenya Avocado Industry Support Project (KAISP)
Technical Note 7: Pruning Avocado

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Section 1: How plants grow

It is important to know how plants grow so that when pruning is needed, the cuts are made at the right places to stimulate the best regrowth.

1 Parts of a plant

Figure 1 below shows the names of all the different parts of a plant. You will have seen all these, but you may not know what they are all called.

Some simple terms for different plant parts:

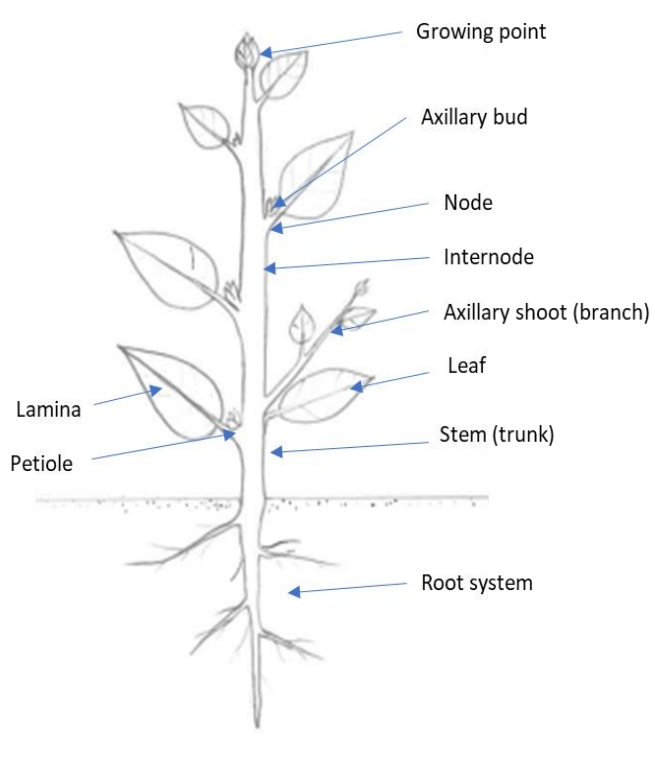

Figure 1. Parts of a plant.

- A leaf has two parts, the petiole (leaf stalk) and the blade (also called lamina)
- The place where the leaf joins the stem is called the node
- The stem between leaves is called the internode (between nodes)
- The position just above where the leaf joins the stem is called the **leaf axil**
- There is a small bud in each **leaf axil**
- These are called **axillary buds** or **lateral buds**. The side branches grow from these buds.
- When the leaf gets old and falls off, it leaves a small scar just below the axillary bud. This is called the **leaf scar**
- The stems will often have small corky scabs on them. These are called **lenticels** and allow air to move in and out of the stem

If all the leaves are removed from a shoot, it will look something like this:

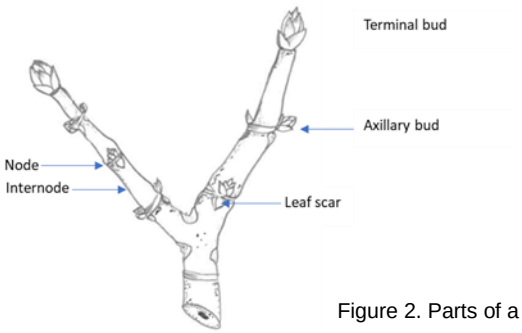

Figure 2. Parts of a shoot.

2 What are plants made from?

- Plants are made up of small building blocks called **cells**
- All parts of the plant are made from cells – bark, wood, leaves, flowers, fruit, roots
- All cells start out being small and thin walled, then change in size, shape and strength as they grow older and do different jobs in the plant
- In the soft and flexible parts of the plant such as very young stems and leaves, the cell walls are relatively thin and mostly made of a chemical called **cellulose**
- In the hard wood in the centre of the stem, the cell walls are very thick and strong and made from a chemical called **lignin**
- The bark is made up of cells that have a corky chemical (**suberin**) in their walls.

3 How do stems grow longer?

- If you pull off the leaves at the tip of the stem, you will find smaller and smaller leaves until they are just small outgrowths that you can hardly see
- At the very end of the stem is a tiny, rounded tip called the **growing point** (also called the apical meristem). You can't see this by eye.

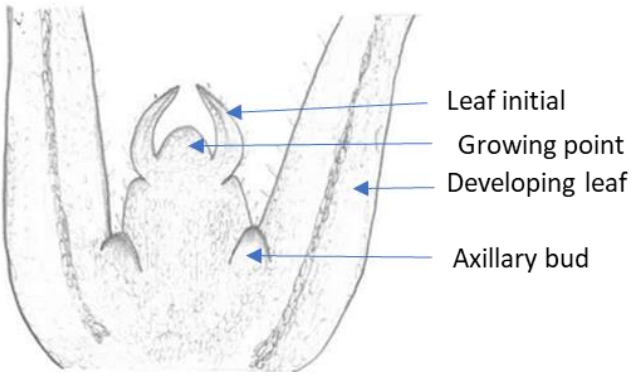

Figure 3. Tip of the stem.

- On the sides of the growing point there are other small outgrowths of cells. These will grow into the leaves

- In the axil of each of the young leaves is another small growing point which will become the lateral (axillary) bud
- The cells of the growing point keep dividing in half, doubling the cell number each time
- Behind the growing point the cells grow longer, causing the whole stem to become longer
- As the cells grow larger they change into different shapes with different functions in the plant.
- Groups of cells of the same kind are called tissues -some develop very thick walls that give strength to the stem
- In avocado, the stem will produce new leaves and grow rapidly for some weeks, then growth slows down and stops. The stem and leaves will harden up and the stem will remain dormant until suitable conditions trigger another period of growth
- These periods of growth are called ‘growth flushes’
- There may be several growth flushes a year
- This is often seasonal, with a major flush in spring, or following rain after a long dry period

4 How do stems grow thicker?

- Inside the stem the different kinds of cells are arranged in layers that have different functions
- In a mature branch or trunk there are generally three distinct layers.
- From the outside they are
- The **outer bark** – the rough corky layer on the outside of the stem
- A thin layer of relatively soft wood called the **cortex.**
- The inner core of strong hard **wood**.
- Between the cortex and the wood is a narrow layer of cells that are continuously dividing and producing new cortex to the outside and new wood to the inside.
- That layer is called the **cambium**
- You will know that term from the piece of climbing equipment called the ‘cambium protector’ which allows the rope to run through steel rings instead of over the branch where it could cut into the bark and cortex and damage the cambium.
- Continual division of cells in the cambium causes the trunk and branches to increase in thickness

5 How do side branches form?

- Branches are formed from the buds in the axils of the leaves
- The growing point of the main stem produces a chemical (called a growth hormone) that slows down or stops new growth from axillary buds
- This is called **apical dominance**.
- In some plants apical dominance is very strong, giving rise to a tall straight stem with smaller side branches lower down on the plant. You can see this in the way eucalypt trees grow.
- To encourage side branches to grow, the top of the main stem is cut off. This removes apical dominance and allows side branches to grow.

6 How do new shoots form on old, pruned trunks and large branches?

- Many of the axillary buds on young shoots never develop into side branches
- As the stem increases in size, it grows over these buds but they stay alive under the bark
- These are called **epicormic** buds
- Many trees also product additional buds in the cortex beneath the bark
- When the top of the trunk or branch is removed and the stem is exposed to light, the epicormic buds start to grown and break out of the bark as new shoots

Figure 4. Epicormic shoots on a pruned avocado trunk.

- These are called **epicormic** shoots and they grow rapidly to rebuild the canopy that has been removed. Rapid regrowth of the canopy is important to maintain food supply to the roots.

7 How are flowers formed?

- Avocado trees normally grow by a series of ‘growth flushes’ when new shoots and leaves are being produced.
- At the end of a growth flush the shoot becomes dormant (no new growth).
- When growth starts again, particularly after a cool spell or a dry period, many of the buds at the ends of the dormant shoots grow out to produce clusters of smooth branches which bear thousands of tiny flowers. This is called an **inflorescence.**

- Most of the flowers fall off – usually only 1-3 flowers on each main branch of the inflorescence will set as fruit.
- Other buds on the end of the dormant shoot produce new growth with leaves and branches extending the canopy of the tree.

Figure 5. Cluster of inflorescence buds at tip of dormant shoot (left) and inflorescences growing from buds on dormant shoots (right).

Section 2: Pruning of young avocado trees

1 Important features of avocado trees

- **Avocado trees in Kenya grow very quickly**
    - The soils and climate in Kenya climate are very suitable for avocado
- **Apical dominance is not strong**
    - The trees produce many branches from an early age
    - Young trees grow upwards and outwards very quickly
- **Most growth occurs on the highest parts of the plant**
    - Sometimes one or more vigorous upright shoots are formed in the centre of the tree
    - They grow above the existing canopy, spread out, and shade out the earlier canopy
    - This leads to a higher and higher tree with very few lower branches
- **Full light is very important for good growth**
    - New shoots growing in full light have short internodes and strong growth
    - New shoots growing in shade have long internodes; they become long and thin in an effort to reach light
    - If the shoots inside the canopy become heavily shaded, they will die
- **Full light is very important for flowering**
    - Shoots shaded from above, or where branches are touching and shading each other, produce very few inflorescences and many do not flower at all.

2 Pruning to produce a “good” tree structure

- The potential size, and shape of an avocado tree is often set during the first few years of growth
- Aim for a tree with a compact, dense canopy and a suitable height which enables fruit to be picked from the ground or a ladder
- The canopies should not touch or grow into each other
    - If all sides are exposed to full light, flowers and fruit will form all over the canopy – top and sides
- The bottom of the canopy (often called the ‘skirt’) should not touch the ground

- Fruit touching the ground can easily be damaged
- A gap between the lowest branches and the soil will allow good air movement and reduce diseases
- There is enough light to allow legumes such as Desmodium to grow as ground cover to reduce erosion, provide nitrogen, and be available for stock feed

3 How to achieve good tree structure

- The final structure of an avocado tree is determined by the number and position of the main limbs selected in the first two years of growth
- Purchase seedlings that have been raised in the nursery with a single stem
- Maintain the tree as a single stem until it is approximately 1.5m high
- Cut the top off the tree approximately 1.0m above the ground
- Select three side branches equally spaced around the trunk just below the cut.
- Those branches will form the main structure of the tree for the future
- Remove all branches below the selected branches
- Remove any side branches that grow across the centre of the tree
- Remove very vigorous upright shoots that grow up from the centre of the young tree
    - They will form a ‘new’ canopy above the old one
    - The new canopy will shade out the old canopy (which will die off) and the tree will have a long trunk and a high

4 Photo guide

Figure 6. Grafted plants raised with a single stem in the nursery (A). Single-stem plant pruned to three main branches forming a strong structure for the tree (B). New growth from a multiple-branch seedling. After harvest, all low branches should be removed and tall shoots thinned to establish am open, strong branch structure (C). If new plants have multiple branches close to the ground, the lower branches must be removed to develop an acceptable tree structure (D). Vigorous shoots that will overgrow and shade out the lower canopy should be cut back to encourage growth of lower branches. Red bars show where cuts should be made (E).

Figure 7. Vigorous vertical shoots overgrowing canopy of young tree; removal of this overgrowth will leave a lower compact canopy.

Section 3: Pruning of mature avocado trees

A large proportion of trees on small orchards in the highlands are very old and very large; the canopies are very high and run together. There is heavy shading which prevents flowering of many branches and yields are very low. Large trees are difficult and dangerous to harvest without damaging fruit.

There are only two options for the rejuvenation of old trees:

1. Removal of the whole canopy and let the tree regrow
2. Progressive reduction of the canopy removing a proportion of the canopy over several years and allowing regrowth on cut branches.

5 Removal of the whole canopy

- Two methods are used:
    - Cutting to near ground level leaving only the stumps (‘stumping’) (Figure 8)
    - Cutting higher to leave short trunks and side branches (‘staghorning’) (Figure 9)

Figure 8. Stumping.

Figure 9. Staghorning.

- Whole canopy removal may not be suitable for all orchards in the Central Highlands
- In many cases new shoots are formed, regrowth is rapid and shoots flower after one year
- Later (4-5 years) rots develop in the original trunks and branches, the canopies stop growing, turn yellow and produce very few fruit
- This common decline of heavily pruned trees appears to be the result of rots and termites invading the wood of the original trunks.
- This is a particular problem with organic orchards because the cut surfaces cannot be protected with fungicidal paints to protect them from rots.
- Sometimes the die-back may be related to pre-existing problems with the root system such as *Phytophthora cinnamomi*

Stumping of old trees

The following photo series shows examples of rotting stumps and weak regrowth following stumping of old trees.

Figure 10. Original stumps rotting (top row) and weak canopy growth and low yield (bottom row),

Regrowth from staghorning

The following photo series shows the four stages of regrowth (on the same tree) following staghorning in August 2014.

Stage 1 – Regrowth begins
November 2014; Regrowth started

Stage 2 – First flowers and fruit
October 2015; First flowers and fruit

Stage 3 – Healthy, fruiting canopy
September 2018; a healthy, fruiting canopy

October 2019; Canopy yellow and weak

Stage 4 – Declining health
October 2019; Rotting of trunk

October 2019; Rotting of trunk

Figure 11. Stages of avocado tree regrowth from staghorning.

6 Progressive reduction of the canopy

- This involves cutting out a proportion of the canopy each year for several years allowing regrowth between pruning
- The advantage is that the tree retains enough canopy to provide fruit and also supports the root system while the pruned part of the tree regrows and starts bearing
- It involves climbing the tree and cutting selected branches from the top downwards using hand saws and chain saws
- It is a highly skilled and dangerous job and should only be attempted by people who have the correct equipment and been professionally trained in safe techniques for climbing and using chainsaws and other pruning equipment in trees.

'Traditional' pruning methods for large trees in Kenya are very dangerous. Chainsaw operators have no personal protection equipment, chainsaws are operated above head height without head protection and the operator stands under the limb being cut. Spectators also stand in range of a falling limb or 'kickback' when it falls (Figure 12, right).

Figure 12. Professionally trained pruner working safely in an avocado tree (left). Spectators in range of falling limbs. Operator standing under limb being cut. Photo by G Thorp, Plant & Food Research (right).

7 Pruning strategy for old trees

- The first strategy applied for reducing the size of old trees in the highlands was to remove approximately one third of the tree at a time, and prune on three occasions about two years apart until the whole canopy has been rejuvenated
- Experience showed that the rate of regrowth is variable and often affected by shading from the remaining canopy or from nearby trees.
- Where there is full exposure to light, the regrowth is strong and produces flowers after the first growing season
- Where there is shading, the regrowth is elongated and weak and does not flower
- In most cases the removal of only one third of the canopy does not allow sufficient light for strong regrowth
- **At least half of the canopy should be removed.**
    - Aim to remove halves of trees that face each other to increase exposure of regrowth to light
    - It is important that at least one strong limb with good canopy is retained to support the root system while the pruned section regrows
- Because of the tree structure, some old trees are not suitable for canopy pruning. For example trees with a tall straight trunk with lowest branches over 3m from the ground cannot be effectively reduced.
- Those trees should be removed completely and new trees planted in their place

8 Pruning of regrowth

- The regrowth on pruned limbs is sometimes very dense
- If left alone some of the new shoots will become dominant and the others will die
- The naturally dominant shoots may not always be in the right place to form a strong, open structure for the new canopy
- When the shoots are well established, three or four the strongest ones that are in the right position should be selected the unwanted ones removed
- The selected shoots will often grow vigorously and upright.
- Just like newly planted trees, the tops should be pruned to encourage growth of the side branches.

Figure 13. Half canopy removed allowing light for regrowth (A and B). One third canopy removed with heavy shade on regrowth (C). Strong regrowth in light (D). Weak regrowth in shade (E).

9 Procedure for pruning large old trees

- Discuss with the grower which trees are to be pruned
- Decide which parts of tree will be removed to provide maximum light for regrowth
- Mark the final cutting point with a tape during the grower discussion
- Aim for cut height of no more than 1.5-2. 0 m
    - If it cannot be pruned to that height, consider whether the tree can be pruned at all.
    - Cutting branches higher will simply rebuild a high canopy

Key points for pruning large trees

- Cut back limbs to remove approximately half the canopy
- Check that the remaining canopy does not overhang the cut limbs
- Remove any overhanging parts of the old canopy
- Sometimes more than half the canopy will need to be removed because of the limb structure or overhanging branches
- When pruning trees that are side by side, remove the sides facing each other – this will provide for maximum light entry
- Ideally prune to leave just one major limb with the supporting canopy
- Trees with a single trunk taller than 3m are not suitable for pruning. The farmer should decide whether to keep them or remove and replant.

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