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### ***Introduction***

Growing a strong crop is one of the most important parts of IPM. Plants that are well taken care of are more resistant to diseases. Raising a crop is like raising children: if you give your crop good food and water, your crop will be less likely to get sick.

As a child grows, his or her needs change. The same is true for tea: the needs of the tea crop change as the tea grows from seedlings to commercial stage to ageing stage. For that reason, the sections of this chapter are arranged according to the crop stage, starting with seedlings.

At the same time as managing the tea crop, the farmer should manage the other plants in the tea field (for example, the trees planted for shade and green manure). For details about managing those other plants, see Chapter Seven.

### ***6.1 Managing the seedling stage***

#### ***6.1.1 Mulching***

The seed and the young seedlings must be carefully protected against weeds and drought. One of the best ways to manage weeds and water is to mulch the field. Mulching simply means covering the surface of the soil with any available plant material: straw, cut grass, tree leaves, ferns, water hyacinth, rice hulls, leaves from green-manure crops, etc. Whatever plant material is used should be harvested before it has produced seeds. If the mulch contains seeds, they may sprout after the mulch is placed in the tea field, producing weeds that will have to be controlled.

Like any practice, mulching has disadvantages as well as advantages (see table on the following page):

Advantages of mulching	Disadvantages of mulching
Reduces soil erosion (by protecting the soil from the impact of raindrops).	Can increase the attacks of termites and other soil insects.
Increases soil moisture (by protecting the soil from sun and wind, and therefore reducing evaporation from the soil).	Can increase problems with root diseases (especially if the mulch is leaves from green-manure plants or other leaves rich in nitrogen)
Helps control weeds.	Collecting and transporting mulch to the tea field takes a lot of labor.
Improves soil structure and fertility (by adding organic matter to the soil).	If mulch leaves are collected from forests, can damage forests and natural areas.
May help control some diseases of tea leaves (by preventing soil from splashing onto leaves during rains).	When mulch dries out, it burns easily, and may increase the risk of fire.
Increases absorption of phosphorous fertilizer by tea plants (probably because mulching increases the production of feeder roots in the surface layer of the soil).	
Easy and cheap.	

If the farmer decides to mulch, use approximately 20-40 tons per hectare. If the farmer does not have enough mulch to cover the entire surface of the soil, mulching can be done in strips that follow the contour of the hill. The mulch should not touch the stems of the tea bushes, because the mulch gets hot and can kill the tender stem tissues. In fields where soil insects are a problem, the mulch should be kept even farther away from the tea plant, leaving a ring of bare soil 15-20 cm diameter (or a bare strip of 15-20 cm along each side of the tea row).

In dry weather, mulch is a fire risk. To reduce the risk of fire, strips of land in both directions (up and down, and side to side) should be kept bare of mulch.

### 6.1.2 Shade trees or green manure plants between rows

Like mulching, shade trees help control weeds and increase soil moisture. Plant "cot khi" trees or other temporary cover crops between the rows of tea, and "muong la ngon" or other permanent shade trees within the rows. If the farmer plans to plant tea cuttings or seedlings from a nursery, it is best to plant "cot khi" one year before planting tea. For more information about planting and managing cover crops (including "cot khi" and "muong la ngon" trees), see Chapter Seven.

### 6.1.3 Other weed management

The combination of mulch and cover crops will control many weeds. But during the seedling stage, the tea crop must be carefully protected from weeds. A circle with a radius of approximately 20 cm around the stem of the bush (or a 20 cm wide band at each side of the tea row) should be kept completely clear of weeds. Weeding should be carried out often, to

ensure that weeds do not produce seeds and do not grow large enough to compete with the tea plants.

If tea seeds are planted directly into the field, the young seedlings must be carefully protected from weeds until they grow to a height of at least 50 cm. After this, normal weeding should be adequate.

### **What is the best way to kill weeds?**

Manual weeding is always preferred to herbicides. Indeed, most farmers have no experience with herbicides, so why get started on the “herbicide treadmill”? Disadvantages of herbicides include:

- Herbicides can disrupt the ecosystem.
- Herbicide use can lead to some weeds becoming resistant to herbicides, requiring higher and higher doses.
- No herbicide kills every weed, so herbicide use selects (favors) the weed species that can survive. These species might actually be harder for the farmer to control compared to the mixture of weeds that were common before beginning to use herbicides.
- Some herbicides can harm tea bushes (example: 2,4-D).

For manual weeding, the best is to pull weeds by hand; although slow, this removes the entire root and does not damage the shallow roots of tea like hoes do. Otherwise, use hoes or spades with thin blades and long handles to dig weeds. Different villages prefer different tools, but it is worth mentioning a few useful tools:

- In Bao Lac (Lam Dong), there is a special kind of spade that on the right side is shaped in a sharp-pointed triangle, which can cut weeds easily and completely.
- Van Linh plantation has experimented with using cattle to rake soil to remove weeds. The rake is a wooden frame including 3 rows of harrow teeth, a handle, and a place where the driver can stand if necessary. Raking is done when the soil is quite wet, then workers pull the weeds out to remove the entire root. Although the rake cannot be used close to fences or tea plants, it reduces working hours and labor intensity.

Whatever tool you use, be careful not to damage the thin white “feeder roots” of the tea, which are concentrated in the top few centimeters of the soil.

Important times for digging weeds are:

- February-March, when young weeds sprout after the spring rains
- August-September, when weeds are growing tall, and
- November, at the end of the crop, when weeds are starting to produce seeds.

During the rainy season, weeds grow so quickly that it is difficult to mobilize enough labor to dig them up. Instead, cut weeds with long-handled knives. This has only a temporary effect; weeds will grow back. Leaving the weed roots in the soil has the additional positive effect of reducing soil erosion during the rainy season.

#### 6.1.4 Other water management

The combination of mulch and shade trees will help manage soil moisture. But in times of drought, it may be necessary to water (irrigate) the tea seedlings. Seeds and seedlings are very sensitive to drought. Some farmers say that watering is more suitable for households that are

located near a water source, and for households that have electricity. Nonetheless, even poorer households far from water sources should consider watering during the seedling stage.

### 6.1.5 Fertilizer, manure, and compost

Compost is a dark, crumbly, spongy material produced by decomposition of organic material. Examples of organic materials that can be composted are: tea prunings, weeds, kitchen waste, green manure leaves and other plant parts, rice straw, animal dung, etc. The composting process normally takes a few months.

Compost, farm yard manure (animal manure and urine, sometimes mixed with the straw from the stable), and chemical fertilizer all provide nutrients (like nitrogen) that the young tea plants need. Each has its advantages and disadvantages:

Amendment for soil	Advantages	Disadvantages
Compost	The best source of beneficial micro-organisms (fungi, bacteria, etc.) for soil.	Requires 2-3 months to make.
	Provides organic matter for soil.	Transport requires lots of labor (low nutrient content, so must transport large amounts to tea field).
	Cheap and easy to make.	
Farm yard manure	Higher nutrient content than compost.	Transport requires lots of labor (although nutrient content is higher than compost, manure is heavy).
	Provides organic matter for soil.	Supply of manure is limited; not enough for all farmers
Chemical fertilizer	Easy to transport (the most concentrated source of nutrients, so only need a small quantity).	Does not provide organic matter for soil.
	Inexpensive.	Can burn young plants.

The main advantage of manure and compost is that they provide organic matter for the soil. Organic matter improves soil structure, water infiltration, and the growth of helpful organisms in the soil. Chemical fertilizer does not provide any organic matter.

The main advantage of chemical fertilizer is that it has a high nutrient content (for example, almost half the weight of urea is nitrogen, whereas buffalo manure has only about 2% nitrogen). So, you only need to apply kilograms of chemical fertilizer per hectare instead of tons per hectare of manure or compost. For this reason, chemical fertilizer is easy to transport and apply. But the disadvantage is, chemical fertilizer does not provide any organic matter to your soil.

**The best strategy for farmers probably is to use all three** (chemical fertilizer, manure, and compost), to benefit from the advantages of each. Indeed, this was the conclusion from the fertilizer experiment conducted during the 1999 TOT course in Phu Tho. The TOT course found that a combination of compost, manure, and chemical fertilizer was more profitable than using just chemical fertilizer, or using just compost and manure.

### 6.1.6 How to make compost

Compost is made by mixing plant materials with a little bit of animal manure and soil, and then allowing bacteria to decompose the plant materials for 1-3 months. Any plant materials can be used: stems and leaves left in the field after harvesting vegetables or maize, rice bran or straw, weeds, grass, leaves from forest trees or green manure trees, scraps and waste from the kitchen, ashes from burning wood or rice, water hyacinth or other weeds from water, etc. You need at least enough material to make a pile that is 1 meter in each direction (1 meter wide, 1 meter long, 1 meter tall). It is easiest to start making compost during the months when you have lots of plant materials (for example, in May-June).

Some farmers like to start by digging a pit in the soil (at least 1 meter by 1 meter, and 70 cm deep). The advantages of a pit are that:

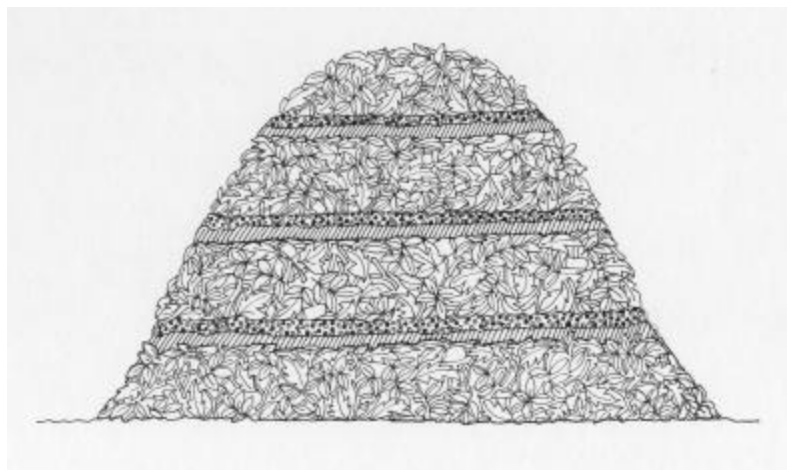
- it holds all the plant materials together (more tidy)
- easier to protect from animals like chickens and pigs
- the pit keeps the plant materials moist during dry weather.

The disadvantages are that digging a pit takes more work. Also, during the rainy months, the pit can fill with water, causing the compost to become waterlogged. This is a problem, because when the compost is too wet, the bacteria cannot get the air they need to do their work. Instead, the compost heap starts to rot which results in the loss of a lot of nitrogen and the production of gasses and acids that are harmful for the plants. Besides, the rotting process also causes the compost heap to get a bad smell. To avoid these problems, instead of digging a pit, you can simply make a pile of the plant materials on the surface of the soil. In very rainy weather, or in low-lying areas, cover the soil with a layer of branches or other coarse materials before piling up your plant materials. This helps air enter from the bottom.

Bring the plant materials you plan to use to the place where you will make the compost. Any large pieces should be chopped up, to make pieces that are no larger than about 10 cm long. Mix different types of plant materials together so that the mixture is neither too wet and green, nor too dry and woody. For example, straw or woody pieces of maize stalks will decompose well only if they are mixed with more succulent green plant material. On the other hand, if you use **only** succulent green plant material, the pile will be so wet and compacted that there will not be enough air for the bacteria.

Once the plant material is chopped and mixed, pile a layer of plant material about 10 cm deep in the bottom of the pit, or on the surface of the soil. Sprinkle some manure on top. The more manure you use, the higher the nutrient content of your compost will be. But if you use too much manure, the pile will be too wet, and will not have enough air for the micro-organisms. Any type of manure can be used: buffalo, chicken, etc. Also, sprinkle on some rich dark soil or some old (finished) compost on top (this is the source of the bacteria and other micro-organisms that will decompose the vegetation). Next, add another layer of plant material, a layer of manure, and a layer of rich soil. Continue adding layers until you have used all the available materials (see the picture on the following page).

The completed pile should be at least 1 meter in each dimension. If it is too small, it will not get hot enough during decomposition (will not hold the heat in). On the other hand, if it is too big, it will be hard for you to turn and mix. So, if you are making large amounts of compost, divide it into several piles instead of making one giant pile.



***Compost pile, showing layers.*** Source: original drawing by Wendy Gibbs.

If the compost heap is build up well, the micro-organisms in the compost will start to become active and, as a result, the temperature of the compost will start to rise. After a few days the temperature should reach 50°C - 70°C and will then go down a bit. It is very important that the compost is kept moist and does not get too dry or too wet. If the compost is too dry, the micro-organisms will not be active and nothing will happen, but if it gets so wet that there is no air inside, the compost heap starts too rot. Remember: a good compost heap never has a bad smell. A bad smell means there is something wrong with the compost heap or pit.

A easy way of checking the humidity of the compost, is by taking a bit of material from the compost heap or pit. If you squeeze this material in your hand and a lot of water runs out, then the compost is too wet. If you open your hand and the material falls apart, then it is too dry. The material is good when you have to squeeze it hard and then a few drops of water come out. If your compost is full of ants and fungi, it also means it is too dry. If the compost produces the smell of rotten eggs, it is too dry.

If the compost becomes too dry, you have to wet it by spraying water. If it gets very wet, mix in dry absorbent materials like straw or dry leaves. Or, put hollow bamboo stalks inside the pile, lying both horizontally and vertically. This helps air to enter the pile. During the rainy season, the heap should be covered with a plastic sheet or coarse dry straw to protect it from the rain.

Every 3 weeks or so, use a shovel or a "fork" to turn and mix the heap. This helps speed up the decomposition. If the compost pile is working successfully (in other words, if the bacteria are rapidly decomposing the plant material), the pile will feel warm and the volume of the pile will be reduced. To check the temperature of the compost, push a stick into the center of the pile. If the stick feels hot when you pull it out, then the bacteria are working. If not, your pile may be too wet or too dry, or you may need to add some more manure.

When the compost is ready to use, it will look like rich soil: dark, crumbly, and spongy. To reach this stage requires about 1-3 months depending on the season (faster in rainy hot weather; slower in dry cool weather). Once it is ready, you can apply it to your tea plantation or use it in the planting holes when you plant new tea plants. Also, spraying plants with a "tea" made by mixing finished compost with cold water can help protect plants from leaf and soil diseases.

### 6.1.7 How much fertilizer should you use?

#### **Manure and compost**

Apply as much manure and compost as possible (10-20 tons or more per hectare is desirable). In practice, the amount will depend on your supply and on how much labor you have available. For most farmers, both animal manure and compost are available only in small amounts. Further, both are heavy, and therefore require a lot of labor to carry uphill and apply.

#### **Chemical fertilizer**

During the seedling stage, plants need less chemical fertilizer than in later growth stages. To decide on the amount of chemical fertilizers, use the following three steps:

1. Choose a rate of nitrogen. For the seedling stage, most books recommend between 30 - 120 kilograms of nitrogen per hectare (for example, this is equivalent to between 65 - 261 kilograms of urea per hectare, because only 46% of urea is nitrogen). But, the exact amount to apply will depend on:

- How fertile your soil is (use less nitrogen if your soil is very fertile). To get some idea about fertility, ask your neighbors how much nitrogen fertilizer they used, and how much tea yield they got in return. But remember: the soil on your farm might be more (or less) fertile than your neighbors' soil. Consider doing an experiment to test several different rates.



For experiments on fertilizer rates, use **study #2 from the Tea IPM Field Guide** as a guide (study entitled "Yield, pest and natural enemy, and disease response to type of fertilizer"). Instead of different types of fertilizers, use different rates of fertilizers. If your experiment includes the fertilizer ammonium sulfate, it would be a good idea to measure the soil pH at the beginning and the end of the experiment. The reason is, ammonium sulfate can make the soil more acidic (lower the pH). For more details, see Section 3.2.4.

- How much money you have available to invest (even though using more fertilizer might increase your tea yield, it might be smarter to use some of the money to invest in other crops or in off-farm activities).

2. Once you have chosen a rate for nitrogen, use about half that rate for phosphorous and potassium. For example, if you plan to apply 60 kilograms of nitrogen per hectare (equivalent to 130 kg urea), then you should apply about 30 kg of phosphorous and 30 kg of potassium per hectare. But as for nitrogen, the exact amounts of phosphorous and potassium will depend on your soil fertility and your finances. As for nitrogen, consider doing an experiment to test several different rates.

3. Once you have chosen the rates for the nutrients (nitrogen, phosphorous, and potassium), calculate how much fertilizer you will need to supply these rates. The amount of fertilizer to apply will always be higher than the rate of the nutrient, because fertilizers contain other things in addition to the nutrient (in other words, fertilizers are never 100% pure). Different fertilizers have different concentrations. Always check the label of the fertilizer to see how concentrated it is. Here are some typical concentrations for some common fertilizers:

<u>Nitrogen fertilizers</u>	<u>Concentration</u>
Urea	46% nitrogen
Ammonium nitrate	35% nitrogen
Ammonium sulphate	21% nitrogen
<u>Phosphorous fertilizers</u>	<u>Concentration</u>
Apatit or appatite	15-35% phosphorous
Simple superphosphate	15-18% phosphorous
Triple superphosphate	44-50% phosphorous
<u>Potassium fertilizers</u>	<u>Concentration</u>
Potassium sulphate	48-50% potassium
Potassium chloride	50-60% potassium

To calculate how much fertilizer you need, first multiply the rate of the nutrient (from step #2) by 100, then divide by the concentration.

Example: If you want to apply a rate of 30 kilograms of phosphorous per hectare, and you want to apply phosphorous in the form of superphosphate, how much superphosphate should you apply?

Answer:  $30 \text{ kilograms} \times 100 = 3.000 \text{ kg}$   
 $3.000 \text{ kg} \text{ divided by } \% = \mathbf{167 \text{ kg of superphosphate per hectare}}$

An example of a mixture of fertilizers that would give rates of phosphorous and potassium equal to half the rate of nitrogen is:

- 130 kg urea per hectare (60 kg of nitrogen per hectare)
- 167 kg superphosphate per hectare (30 kg of phosphorous per hectare)
- 63 kg of potassium sulphate per hectare (30 kg of potassium per hectare)

But this is just one example; each farmer should choose his or her own rates according to soil fertility and household economy.

### **What method should you use to apply fertilizers?**

Fertilizers should always be applied during the rainy season and when the tea plants have plenty of leaves. Divide the total quantity to be applied among 2-4 application dates during the rainy season (from March to October). Fertilizer should never be applied right after pruning, because leafless plants cannot absorb nutrients from the soil.

Fertilizer that is absorbed by one root only reaches particular branches of the tea bush. So, if you apply fertilizer only on one side of the root system, some branches of the bush will not receive the full benefit. For young plants, fertilizer should be applied in a ring around each plant, but not touching the stem. Once plants have formed a hedge, apply on the sides of the hedge and also in the spaces inside the hedge. Some experts recommend burying fertilizer in the soil to reduce losses from run-off. But, this requires more labor, and some studies show that burying fertilizer does not increase absorption by the tea plant. If you do bury fertilizer, be careful not to damage the delicate feeder roots that are concentrated in the top few centimeters of the soil.





### Why spend money on phosphorous or potassium fertilizers?

Because they are just as important for the plant as nitrogen is. Fertilizing a plant is a bit like feeding a child. A child needs energy foods like rice. But if the child eats only rice, and does not eat protein foods like meat or tofu, the child will get sick. A child can "starve" with a belly full of rice, if it does not eat any protein.

The situation is similar for a tea plant. A tea plant needs nitrogen, but it also needs phosphorous and potassium. A plant can "starve" with the soil full of nitrogen, if the soil does not contain any phosphorous or potassium.

Plants need **nitrogen** to make proteins, which make up part of the structure of the plant. In addition, some proteins (called enzymes) help manufacture other necessary chemicals inside the plant.

As important as nitrogen is, if the plant is given **only** nitrogen, it will starve. Plants also need:

**Phosphorous**, which the plant uses to make energy-rich chemicals that serve as fuel for many chemical reactions. Phosphorous is also an essential part of DNA, the chemical that forms the genes that help determine the structure and function of every cell in the plant.

**Potassium**, which works as a partner with enzymes (the proteins that manufacture chemicals). In addition, plants use potassium to regulate the concentrations of salts and water throughout the plant. Also, potassium helps increase the plant's resistance to some diseases (for example, potassium increases the resistance of tea to nematodes; see Section 11.4.2).

So, don't spend all your money on nitrogen; you'll be wasting your money. Instead, use it to buy a balanced mixture of nitrogen, phosphorous, and potassium. For example, for the seedling and branch-formation stages, to calculate how much phosphorous and potassium to apply, divide your nitrogen rate by about 2.

In Thanh Ba Province in 1996, tea farmers in 3 communes (Dong Xuan, Khai Xuan, and Thai Ninh) did experiments comparing applications of only nitrogen with applications of a balanced mixture of nitrogen, phosphorous, and potassium. The mixture gave higher yields, higher tea quality, and higher profits than the application of nitrogen alone.

#### 6.1.8 Folding the tips of spindly seedlings

Pruning is not recommended during Year 1. Nonetheless, if a young plant is very thin and spindly during Year 1, it is sometimes useful to fold over the tip of the young plant without breaking it off. This concentrates the energy of the plant in the lower part of the plant, helping it to grow thicker and stronger and preventing it from falling over.

## **6.2 Managing the branch formation stage**

### 6.2.1 Mulching

Mulching was already discussed for the seedling stage, but is equally important for the branch formation stage. If you do not have enough mulch to protect the soil, consider planting green manure plants between rows, or permitting useful weeds to grow between rows (see the following two sections).

### 6.2.2 Green manure plants between rows

Until the leaves of neighboring tea bushes are touching, you can continue to grow temporary cover crops such as “cot khi” between the rows of tea. “Cot khi” and other green manure plants should be pruned several times each year, and the pruned branches left on the ground as green manure. During the branch formation stage, there is still time to plant “muong la ngon” or other permanent shade trees within the rows of tea to provide shade and green manure once the tea reaches the commercial stage. For more information, see Chapter Seven.

### 6.2.3 Other weed management

The combination of mulch and cover crops will control many weeds. During the branch formation stage, tea plants are less susceptible to weeds than during the seedling stage. Nonetheless, in Viet Nam many hectares of tea in branch formation stage have been ruined in recent years by being overgrown by weeds. As always, the goal of the farmer should be to maintain an ecological balance that recognizes both the good and bad effects of weeds:

#### **Some helpful effects of weeds:**

- Reduce soil erosion by covering the soil (the green part of the weed plant) and by holding the soil (the roots of the weed plant) during the wet season.
- Provide food for insect natural enemies. Weeds can provide food directly (pollen and nectar from flowers), or indirectly (natural enemies eat other insects that live on weeds; for example, natural enemies of green leafhopper eat related insects on weeds).
- Deep-rooted weeds help break up hard layers in the soil, and help pull nutrients up from deep in the soil.

#### **Some harmful effects of weeds:**

- Compete with tea plants for water and sunlight.
- Some weeds provide food for pest insects that also feed on tea.
- Interfere with the work of tea pluckers (especially thorny or climbing weeds such as mimosa, day-flowers, or lygolium).

How can farmers take advantage of helpful weeds while minimizing their harmful effects? Unfortunately, there is no simple answer. Farmers need to study the weeds in their fields to learn which weeds are most dangerous and which are helpful:



Farmers should do Study #7 from the Tea IPM Field Guide (study entitled “Effects of different weed management methods on tea ecosystem and yield”).

After several farmers' groups have done this study in nearby villages, you will have the information you need to make rational decisions about how to manage weeds. Until then, here are three general guidelines for managing weeds:

1. Do not permit any weeds to grow very close to the tea plants. For example, use a hoe or other tool to clear a circle with a radius of about 20 cm around each tea plant (or a 20 cm wide band on each side of the tea row). Keep this area mulched (but do not allow mulch to touch the tea stems).
2. Farther away from the tea plants (between tea rows), it may be a good idea to allow the growth of useful weeds. Especially, allow the growth of weeds that reduce soil erosion and weeds on which many natural enemies are found. Natural enemies often like weeds with white or yellow flowers. But unfortunately, thrips (an insect pest of tea) sometimes also like these same weeds! Have farmers sample the insects found on different weed species.
3. Three types of weeds are difficult to control, and probably should not be allowed to grow even between tea rows:
  - weeds that survive for more than one year ("perennial" weeds)
  - weeds that can send up new shoots from thick roots (tubers) or thick stems (rhizomes or runners)
  - weeds with tough vines or sharp thorns

Some of the weed species that should be carefully controlled include:

Vietnamese name	Scientific name
Cay cut lon	<i>Ageratum conyzoides</i>
Co may	<i>Chrysopogon acicullalus</i>
Co thai lai	<i>Commelia nudiflora</i>
Co ga	<i>Cynodon dactylon</i>
Co gau	<i>Cyperus rotundus</i>
Co chi	<i>Digitaria marginata</i>
Co man trau	<i>Eleusine indica</i>
Co lao	<i>Eupatorium odoratum</i>
Co te	<i>Gleichenia linearis</i>
Co tranh	<i>Imperata cylindrica</i>
Cay xao ho xanh	<i>Mimosa invisa</i>
Cay xao ho do	<i>Mimosa pudica</i>
Co che ve	<i>Micanthus japonicus</i>
Bai ngai	<i>Oldenlandia auricularia</i>
	<i>Oleodendron cryptophyllum</i>
Chua me dat	<i>Oxalis corniculata</i>
Co gung	<i>Panicum repens</i>
Co cong vien	<i>Paspalum conjugatum</i>
Co bong bong	<i>Zigodium scandans</i>

[note change in scientific name Imperata cylindrica ]

For details about how to control weeds, see the section on weed management in the seedling stage (Section 6.1, above).

#### 6.2.4 Other water management

The combination of mulch and shade trees will help manage soil moisture. During branch formation stage, watering (irrigating) the tea plants is probably suitable only for households that are located near a water source and that have electricity for pumps.

#### 6.2.5 Fertilizer, manure, and compost

To decide how much fertilizer to use during branch formation stage, follow the three steps already discussed in the section entitled "How much fertilizer should you use?" under the seedling stage (Section 6.1), with the following change for chemical fertilizers:

1. During branch formation stage, most books recommend more nitrogen than during seedling stage (between 40 – 200 kilograms nitrogen per hectare per year).

As for the seedling stage, the exact amount of nitrogen to use will depend on soil fertility and on your household economy. And as for the seedling stage, once you have chosen a rate for nitrogen, use about **half** that rate for phosphorous and potassium.

Note that in very acid soils, tea plants may need another nutrient, zinc. Plants that do not have enough zinc show:

- small leaves (may be very pale)
- shorter distance between leaves on the stem (short "internodes")
- longer period of dormancy ("sleeping").

If plants seem to be deficient in zinc, apply a total of between 8 - 30 kilograms of zinc sulfate per hectare, divided among 4 application dates per year. Apply zinc sulfate by mixing with water and spraying onto the bushes after plucking. If you are not sure that the plants need zinc, apply it on only part of the field, then compare the health of plants in the two areas.

#### 6.2.6 Pruning

During branch formation stage, the purpose of pruning is to shape the way that the main frame of large branches are growing, so that the bush becomes:

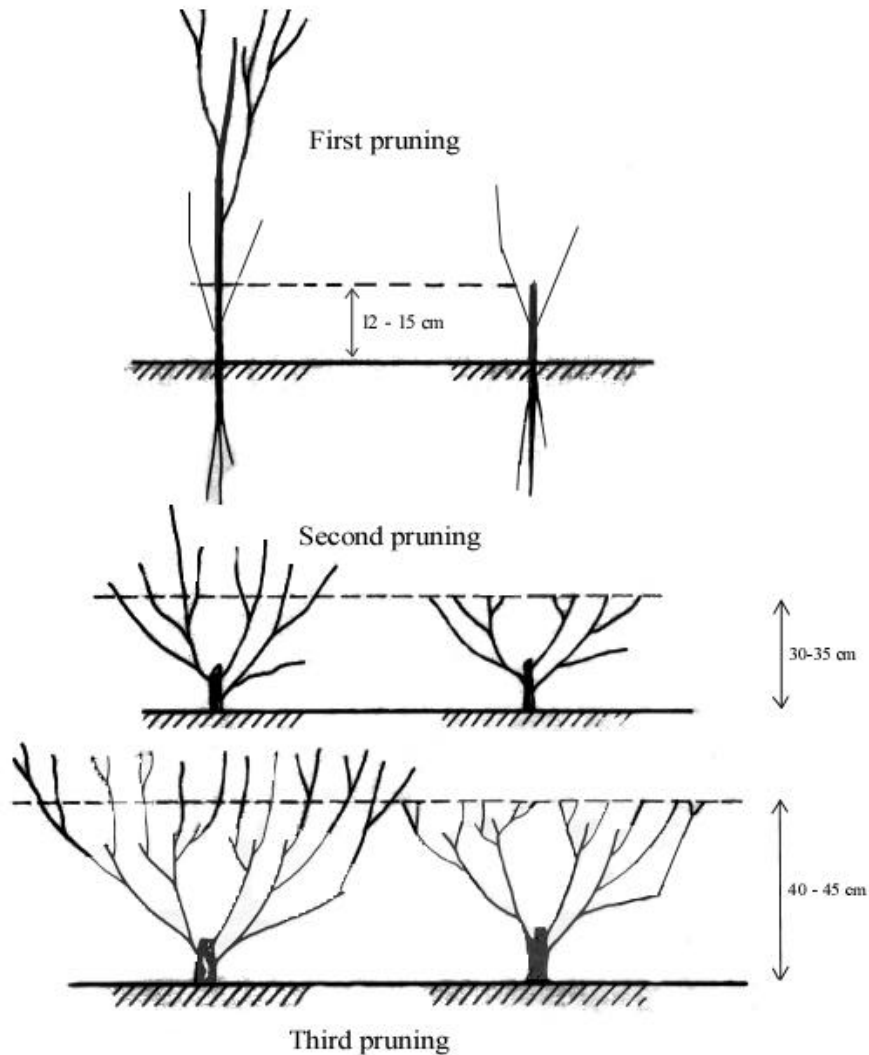
- low (within reach of pickers); the plucking table should be at a height of about 70 cm
- broad, with many strong, healthy branches
- large canopy capable of producing many shoots

Pruning is not recommended during Year 1. Nonetheless, if a young plant is very thin and spindly during Year 1, it is sometimes useful to fold over the tip of the young plant without breaking it off. This concentrates the energy of the plant in the lower part of the plant, helping it to grow thicker and stronger and preventing it from falling over.

The first pruning is done when the diameter of the main stem is more than 0,7 cm, and the height of the plant is more than 70 cm.

**For tea grown from seeds**, a total of three annual prunings are needed to shape the frame of the bush (see drawing). The first pruning, or cutting back of the central stem, is done at a height of 12-15 cm from the ground, usually at the end of Year 2 or beginning of Year 3 (mid-December to January). In this first pruning, cut only the central stem. Do not cut the branches even if the tips of the branches are growing higher than 15 cm above the ground.

The second pruning, 12 months later, is done at a height of 30-35 cm. The third pruning, 12 months after the second, is done at 40-45 cm. Pruning is always done in December-January.

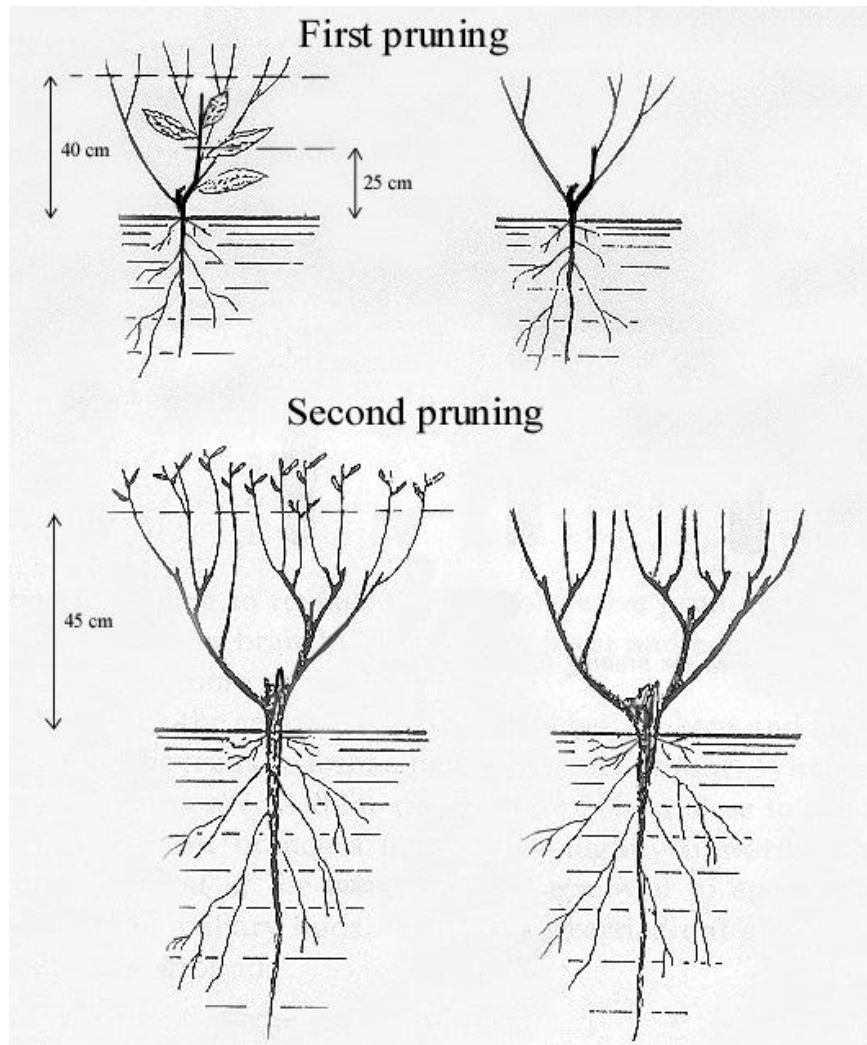


***Pruning for young plants grown from seeds.***

*Source: adapted from Bonheure, D. 1990. Tea. In the series entitled The Tropical Agriculturalist. Maissonneuve et Larose, Paris.*

**In tea grown from cuttings**, the side stems grow more than on tea grown from seeds. Also, tea grown from cuttings tends to have more stems and bigger stems. For both of these reasons, only 2 formative prunings are needed.

Again, the first pruning is done when the diameter of the main stem is at least 0,7 cm and the height of the plant is at least 70 cm. This first pruning is usually done at the end of Year 1 or the beginning of Year 2 (mid-December to January). In the first pruning, cut the main stem 25 cm above the ground, and the other stems at a height of 40 cm above the ground. The second pruning is done one year later, at a height of 45 cm above the ground.



***Pruning for young plants grown from cuttings.***

*Source: adapted from Bonheure, D. 1990. Tea. In the series entitled The Tropical Agriculturalist. Maissonneuve et Larose, Paris.*

### **When is the best time to prune?**

At least during branch formation stage, the best time for pruning is from mid-December to January (before the Tet holiday). Once the tea reaches commercial stage, however, some farmers prune after Tet (see Section 6.3, below).

Before doing the first pruning (at the end of Year 2), you should check to make sure that the young bushes have stored enough energy (starch) in their roots. They will need a good store of energy to recover from pruning. To check, apply iodine solution to the cut end of roots and watch for a color change. You can buy iodine solution in pharmacies (it is used for disinfecting cuts). When iodine touches starch, the starch turns blue (try it with rice grains as a test; rice grains contain starch). To check whether young plants are ready for pruning:

1. Dig a hole 10 cm from the stem of the young tea plant and 15 cm deep.
2. Cut off and save any large roots that are exposed by the hole (use only roots that are at least half a centimeter in diameter).
3. Make smooth cuts across the ends of the roots and hold the roots vertically.
4. Apply a drop or two of iodine solution to the end of each root. Hold the roots vertically for 5 minutes, then shake off the iodine.
5. Note how much blue color is produced. A deep blue color spread across the entire cut surface of the root indicates a high concentration of starch, and therefore the plants will have enough energy to recover from pruning. If the roots are very pale or do not change color, they have not yet accumulated much starch, and therefore you might want to delay the first pruning.

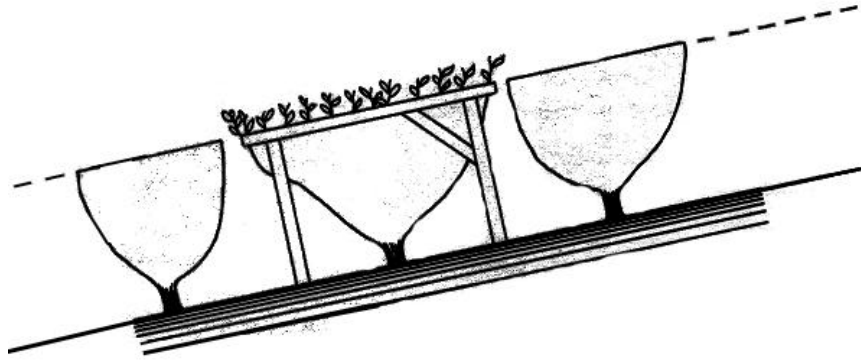
### **How should pruning be done?**

All prunings are done using a pruning knife (long blade and short handle) or secateurs (clippers). Secateurs can have short blades to cut small branches (used with one hand) or long blades for big branches (used with two hands). If you use secateurs, be sure they are sharp; if dull, they will crush the stem and slow the growth of the tea plant. It is best to “polish” the cuts with a sharp knife so that water cannot stick to the cut surface (if the cut stays wet, it is more likely to get diseases).

Always cut branches from the inside to the outside, forming a wound at an angle of 45° to allow any water to drain (high side of each wound facing outwards on the bush). When the high sides of the cut branches are on the outside, then the new shoots also will grow towards the outside of the plants, creating a bigger plucking surface.

The tops of the bushes should be cut parallel with the slope of the hill (see drawing on next page). If you don't do that, then the part of the tea bush at the higher end of the slope will develop more slowly than the part at the lower end (less new leaves and shoots will develop on the higher end). There is only one small exception to the rule of pruning parallel to the slope. That is, it is sometimes also recommended to prune the center of each bush a little bit more than the outside, creating a “hollow” shape of the bush. The reason is, the center of the tea plant always grows faster than the outside.

To reduce sun scorch damage, cover the frame of the bush with the branches and leaves removed during pruning. If the tea has fungus diseases, or if the bush frame is heavily overgrown with lichens or algae, it is helpful to wash the frame with lime or caustic soda mixed with water.



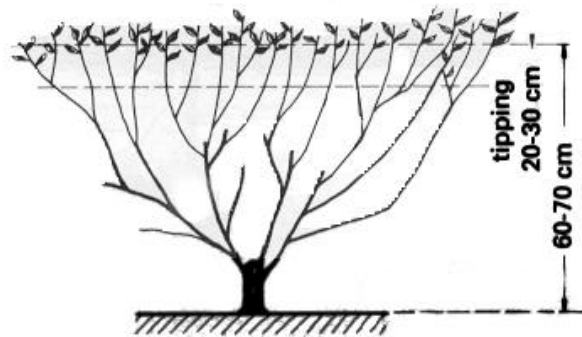
**Pruning should be done in such a way as to keep the plucking surface parallel with the slope of the hill.** The only exception is, the center of each bush should be pruned a bit more deeply than the outside. Source: adapted from Bonheure, D. 1990. Tea. In the series entitled *The Tropical Agriculturalist*. Maissoneuve et Larose, Paris.

#### 6.2.7 Plucking

Do not pluck during year 1. During year 2, tea still needs leaves to produce energy to grow branches. Therefore, only do light plucking and only pluck during the flushing period, when the tea is growing rapidly (usually June-September). Avoid early and heavy plucking.

In the spring of year 3, after the first pruning, plucking must not start until the tea plant has grown enough shoots and leaves to restock its reserves of energy. Therefore, wait until new shoots have grown 20-30 cm above the level of pruning (usually by early April). This is called the "tipping level" (see drawing). Then, use your fingers to break off the new shoots at the tipping level. This is called "tipping", and it has 2 purposes:

1. To create a flat canopy (called the "plucking table") parallel to the slope, and
2. To cause the buds on the sides of the shoots to open, so the bush will grow many more shoots (branches and sub-branches will grow from the sides of the tipped shoots).



#### **Tipping level in late branch formation tea.**

Source: adapted from Bonheure, D. 1990. Tea. In the series entitled *The Tropical Agriculturalist*. Maissoneuve et Larose, Paris.



After tipping, any shoots that grow above the “plucking table” can be lightly plucked. You probably will not harvest many buds during year 3, but your labor costs for tipping will be rewarded by higher yield in future years.

In year 4, after the second pruning, again follow the directions for tipping. The tea should then enter the commercial stage if it has received good care. Plucking for commercial stage is described in Section 6.3 (below).

### **6.3 *Managing the commercial stage***

#### 6.3.1 Mulching

As for branch formation stage (discussed in Section 6.2)

#### 6.3.2 Shade trees within rows

Once tea enters commercial stage, it is necessary to remove most cover crops or green manure plants like “cot khi” from between rows, so that pickers can walk easily. Leave no more than one row of green-manure plants for every four rows of tea. Therefore, green manure must now come from leaves carried in from outside, or from shade trees such as “muong la ngon” planted within the tea rows. See Chapter Seven.

#### 6.3.3 Other weed management

By now, the tea canopy has closed, so weeds within the tea hedges are less of a problem. You should still keep a weed-free band on each side of the hedge. Between the hedges, weeds should be low enough to allow the pluckers to walk easily. Otherwise, follow the recommendations from the branch formation stage (above).

#### 6.3.4 Other water management

Watering the tea is often profitable, but limited to areas near a water source. By watering the tea fields, it is possible to take advantage of late pruning around Tet, when the price of tea is about three times higher. Plants that have not been pruned in winter need more water because they still have many leaves.

#### 6.3.5 Fertilizer, manure, and compost

To decide how much fertilizer to use during the commercial stage, follow the three steps already discussed in the section entitled “How much fertilizer should you use?” under the seedling stage (Section 6.1), with the following change for chemical fertilizers:

1. The commercial stage requires more nitrogen than the previous stages. Most books recommend between 80 — 300 kilograms nitrogen per hectare per year. Note that high levels of nitrogen may reduce tea quality, even though they increase the quantity of buds harvested.

The exact amount of nitrogen to use will depend on your soil fertility and on your household economy. In other words, even though using more nitrogen might increase your tea yield, it might be smarter to use some of your money to invest in other crops or in off-farm activities, instead of using it to buy nitrogen fertilizer.

The exact amount of nitrogen will also depend on how much tea you usually harvest (or your goal for how much you want to harvest). As an approximate guide, use about 20-25 kg of nitrogen for each ton of fresh tea that you harvest. For example, if you usually harvest 5.000 kg (= 5 tons) of fresh tea per hectare, then use about 100 kg of nitrogen per hectare:

$$5 \text{ tons/ha} \times 20 \text{ kg nitrogen/ton} = 100 \text{ kg nitrogen/ha}$$

This would be equivalent to 217 kg of urea/ha, because only 46% of urea is nitrogen.

2. Once you have chosen your rate of nitrogen, divide it by about 3 to calculate your rates of phosphorous and potassium. For example, if you plan to apply 120 kg of nitrogen per hectare, then you should apply about 40 kg of potassium per hectare:

$$120 \text{ kg nitrogen/ha divided by } 3 = 40 \text{ kg potassium per hectare}$$

That would be equivalent to 80 kg of potassium sulphate per hectare, because only about 50% of potassium sulphate is potassium (see Section 6.1 for more details).

Some experts say that it is more profitable to increase the rate for potassium (for example, divide by two instead of three for potassium). The only way to know for sure is to do experiments on individual farms.



For experiments on fertilizer rates, use study #2 from the Tea IPM Field Guide as a guide (study entitled “**Yield, pest and natural enemy, and disease response to type of fertilizer**”). Instead of different types of fertilizers, use different rates of fertilizers.

Once you have chosen the rates for the nutrients (nitrogen, phosphorous, and potassium), calculate how much fertilizer you will need to supply these rates. The amount of fertilizer to apply will always be **higher** than the rate of the nutrient, because fertilizers contain other things in addition to the nutrient (in other words, fertilizers are never 100% pure). See Section 6.1 for more information.

### 6.3.6 Foliar fertilizers

Many nutrients can be applied by spraying onto the leaves of tea plants. For example, foliar applications of zinc were discussed in the branch formation section (above). However, some nutrients must be applied in special soluble forms (in other words, it is not always possible to spray the ordinary fertilizers that you would apply to the soil).

Some advantages of foliar fertilizers:

- Rapidly absorbed (within hours, instead of within days or weeks if applied to soil). Therefore, foliar fertilizers are the best way of curing the symptoms of nutrient deficiencies, especially deficiencies of micro-nutrients (see Chapter Eleven).
- Not dependent on soil conditions. In contrast, fertilizers applied to soil may not be absorbed if soil is too dry, or if soil has high concentrations of other nutrients, or if soil pH is too extreme.
- Serve as a form of irrigation. The water used to apply foliar fertilizers can, itself, benefit the plants.

Some disadvantages of foliar fertilizers:

- Can be expensive (commercial foliar fertilizers).
- Absorption is low if plants are drought-stressed. Absorption is through pores (“stomata”) on the bottoms of leaves (see Chapter 4 for explanation). On hot sunny days, and especially if plants need water, these pores can be closed.
- Application requires water, and requires more labor than scattering fertilizer on the soil.

There are several commercial foliar fertilizers, including: Thien Nong, Komic (or Komix), Humix, Nuca, VCC. The commercial products are supposed to be mixtures of many nutrients. However, some products do not list their ingredients, so it is hard to be sure what you are really buying. An interesting alternative is to **make your own foliar fertilizer**. The following “recipe” gave good results at the TOT course in Phu Tho in 1999. It makes enough for one sao of tea (about 12 liters total). So, multiply the quantities in the recipe by the number of sao you want to spray:

Green manure solution: Collect 1 kg of green manure leaves. Chop into small pieces. Place into 2,5 liters of clean water, let sit for one week. Strain the liquid to remove leaves. Dilute the strained liquid 1:1 with clean water.

Urine solution: Collect 5 liters of urine. Dilute 1:1 with clean water.

Mix the two solutions together and spray onto foliage of one sao of tea.

### **Should I apply foliar fertilizers?**

If your tea plants show deficiency symptoms as described in Chapter Eleven, it may be cost-effective to apply a foliar fertilizer. Some fields may benefit even though they do not show deficiency symptoms. For example, experiments by Phu Tho farmers in 1996-97 showed that applying a combination of the foliar fertilizer Komic plus a growth stimulant (Atonic or Diep Luc To) improved bud density and tea color, increased yield by 43% compared to spraying only water (control), and greatly increased farmer profits. Tea Research Institute reports yield increases of about 30% from commercial foliar fertilizers in fields that did not show any obvious deficiency symptoms.

Best of all, the 1999 TOT course in Phu Tho found that their **home-made foliar fertilizer (green manure plus urine recipe) gave better results than one of the commercial products**. The green manure/urine mixture increased tea yield and number of buds, and gave 30% higher profits than the commercial product. But, don't take their word for it; do an experiment for yourself:



For experiments on foliar fertilizers, use study #6 from the Tea IPM Field Guide as a guide (study entitled "Effects of growth stimulants and foliar fertilizers on tea").

**WARNING: be sure to compare the weights of dry tea produced when you do an experiment on foliar fertilizers.** In all of the experiments that we have seen, farmers measured only the amount of fresh tea that they harvested. But, you are paid for the weight of dry tea that you produce. We are concerned that plants treated with foliar fertilizers are producing buds with more water in them (soft, plump, green buds). More water in the buds is not necessarily bad, but it would not increase farmer income. Instead, the water would just evaporate during the tea drying. So, be sure to compare weights of dry tea.

### **What is the best way to apply foliar fertilizers?**

If you decide to apply a commercial product, **follow the label instructions**. The Tea Research Institute reports that the common practice is to apply commercial foliar fertilizers during the summer crop and at the end of the harvest period.

If you make your own fertilizer, it is probably best to apply it during the months when tea is most drought-stressed (for example, April-June). That way, the tea will get the most benefit from the water itself. Alternatively, apply during the months when you notice deficiency symptoms. For example, the Tea Research Institute reports that tea usually shows symptoms of deficiencies of boron, magnesium, and manganese at the end of the summer.

Whichever month you choose, apply during a cool part of the day so that:

1. The drops of spray will stay on the plant a long time (not evaporate quickly). If the drops evaporate quickly, the fertilizer may remain on the leaf surface as a powder, and be lost when the plants are plucked or pruned.
2. The pores on the bottoms of the leaves will be open to absorb the fertilizer.

### **6.3.7 Growth stimulants**

Although growth stimulants are applied to the foliage, they are not fertilizers. Fertilizers are the materials that the plant's "construction team" will use to construct new tissue (see Chapter Three for details about how plants use fertilizers). In contrast, growth stimulants are like drugs that make the plant's "construction team" work harder. Some common commercial growth stimulants are: Atonic (or Atonik), Diep Luc To, GA3, CSF002.

Like some foliar fertilizers, some commercial growth stimulants do not list their ingredients. Therefore, it is hard to be sure what you are really buying. But many growth stimulants contain plant hormones, especially the hormone "gibberellic acid" (see the box on the next page). All tea plants naturally produce small amounts of hormones like gibberellic acid. But, spraying tea plants with commercial growth stimulants temporarily increases the amount of hormones in the tea leaves, buds, and stems.

### **Should I apply growth stimulants?**

**We have not yet seen any experiments that prove the usefulness of growth stimulants in tea.** In Thanh Ba District, Vinh Phu Province in 1996, tea farmers found that the stimulants Atonic and Diep Luc To each increased yields by about 20%, but this increase was not enough to repay the cost of the stimulant. Similarly, in an experiment in the 1999 TOT training in Phu Tho, the stimulant Diep Luc To gave lower yields and lower profits than either diluted urine or green manure sprays. Further, one Tea Research Institute document recommends using foliar fertilizers that provide mineral substances only in moderation, and to avoid using any product that is exclusively a growth stimulant. Nonetheless, it is possible that some stimulants would be profitable in some fields in some years. If you decide to try a stimulant, be sure to leave part of the field untreated, and compare the profitability in the two parts of the field.

### **What is the best way to apply stimulants?**

Follow the label instructions.



## What are plant hormones?

All plants produce small amounts of hormones. Hormones are chemicals that carry information from one part of the plant to another. A hormone is like a letter: one part of the plant sends the letter, then the letter travels to another part of the plant, which receives the letter. In plants, the “letters” (that is, the hormones) travel in the sap of the plant. When the hormone is received by a part of a plant (for example, received by a bud), the recipient knows that it is time to take a certain action (for example, time for the bud to open).

There are three main hormones in plants (3 types of “letters”), each of which triggers a different action by the plant tissue that receives the hormone:

1. Gibberellic acid: Stimulates cells in the “division zones” of buds to divide and produce new cells (see Section 4.1). For this reason, gibberellic acid sometimes can “wake up” sleeping buds, causing the tea plant to start growing earlier in the year.
2. Auxin: In normal concentrations, auxin stimulates new cells (formed by cell division) to grow longer. In high concentrations, auxin inhibits cell growth. For example, by producing high concentrations of auxin, growing buds at the tips of shoots inhibit the growth of the buds along the sides of the shoot.
3. Cytokinin: Works as a partner with auxin to promote cell growth and fruit production by flowers.



For experiments on growth stimulants, use study #6 from the Tea IPM Field Guide as a guide (study entitled “**Effects of growth stimulants and foliar fertilizers on tea**”).

**WARNING:** be sure to compare the weights of dry tea produced when you do an experiment on growth stimulants.

In many experiments, farmers measure only the amount of fresh tea that they harvest. But, you are paid for the weight of dry tea that you produce. Plants treated with growth stimulants might produce buds with more water in them (soft, plump, green buds). More water in the buds is not necessarily bad, but it would not increase farmer income. Instead, the water would just evaporate during the tea drying. So, be sure to compare weights of dry tea.

### 6.3.8 Plucking

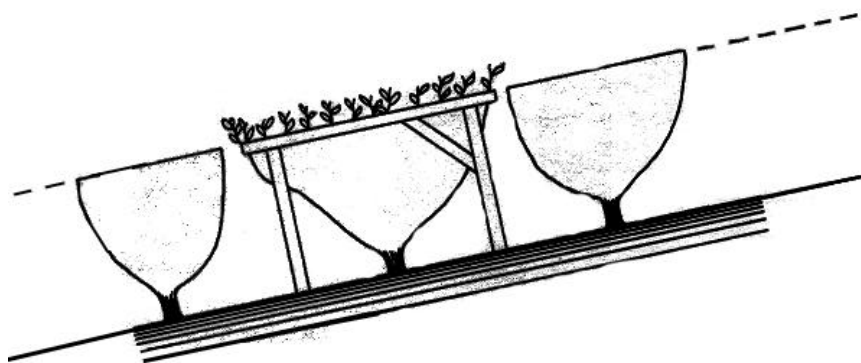
The main purpose of plucking is to harvest the tea. But in addition, plucking can affect the long-term health of the tea plant, and can help with insect and disease management. Therefore, when farmers do experiments to decide which plucking method is best, they should measure plant health and pest damage, not just tea yield and quality.

#### **When to pluck: time of year**

Plucking must not start until the tea plant has grown enough shoots and leaves to restock its reserves of energy. After every pruning (December-February), a layer of leaves is allowed to grow 20-30 cm above the level of pruning. Therefore, wait until new shoots have grown 20-30 cm above the level of pruning (usually by early April). This is called the “tipping level” (see drawing on the next page). Then, use your fingers to break off the new shoots at the tipping level. This is called “tipping”, and it has two purposes:

1. To create a flat canopy (called the “plucking table”) parallel to the slope, and
2. To cause the buds on the sides of the shoots to open, so the bush will grow many more shoots (branches and sub-branches will grow from the sides of the tipped shoots).

After tipping, any shoots that grow above the “plucking table” can be lightly plucked. Shoots should be plucked during the “flushing period” (when the tea plant is growing actively). In general, the flushing period is during spring and summer, with highest yields from June-September. But the exact timing of the flushing period is different for different tea varieties (this was discussed in Section 5.1). Before and after the flushing period, the tea plant is dormant (sleeping). Plucking during the months when the tea is dormant is an extra strain on the tea plant. Nonetheless, some farmers believe that if the crop is well cared for, tea can tolerate plucking even during the dormant period.



***Tipping should be done in such a way as to keep the plucking table parallel with the slope of the hill.*** Source: adapted from Bonheure, D. 1990. *Tea*. In the series entitled *The Tropical Agriculturalist*. Maissonneuve et Larose, Paris.

### **When to pluck: time of day and type of weather**

Plucking should be done in the morning, for two reasons. First, and most important, plucking in the morning leaves enough time so that the plucked tea can be processed the same day (in the afternoon). If plucked tea is kept overnight before processing, the quality will be much lower (see Chapter Thirteen). A second (less important) reason is that the quality (flavor) of tea is highest from shoots harvested in the morning, because the chemical quality of the shoots is higher in the morning (less soluble sugars and more catechins in the morning).

Shoots grow fastest and produce energy for the plant most efficiently from about 8:00 a.m. to about 11:00 a.m. Therefore, tea production would be a bit higher if plucking started late in the morning, instead of starting in the early hours. But, this may not be possible due to labour demands.

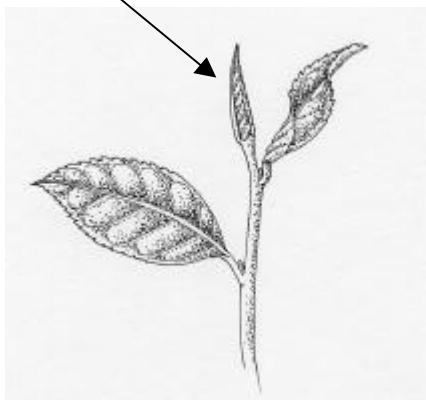
Do not pluck on rainy days; the wet tea takes too long to dry during processing, which reduces quality.

### **What to pluck:**

Pluck only shoots that are growing above the flat canopy ("plucking table"). Pluck two kinds of shoots:

1. Actively growing shoots that have at least 2 true foliage leaves above the rounded "fish leaf". Never pluck immature shoots (buds, or buds + 1 leaf) (see drawing).
2. In addition to actively growing shoots, "blind" or "banjhi" buds should be plucked if they are growing above the tipping level. These are dormant buds at the top of shoots that are not producing new leaves (see drawing). Plucking these buds (banjhi bud plus one young leaf) encourages the buds on the sides of the shoot to open and produce new shoots.

Young "shrimp" leaf  
(not yet unrolled)



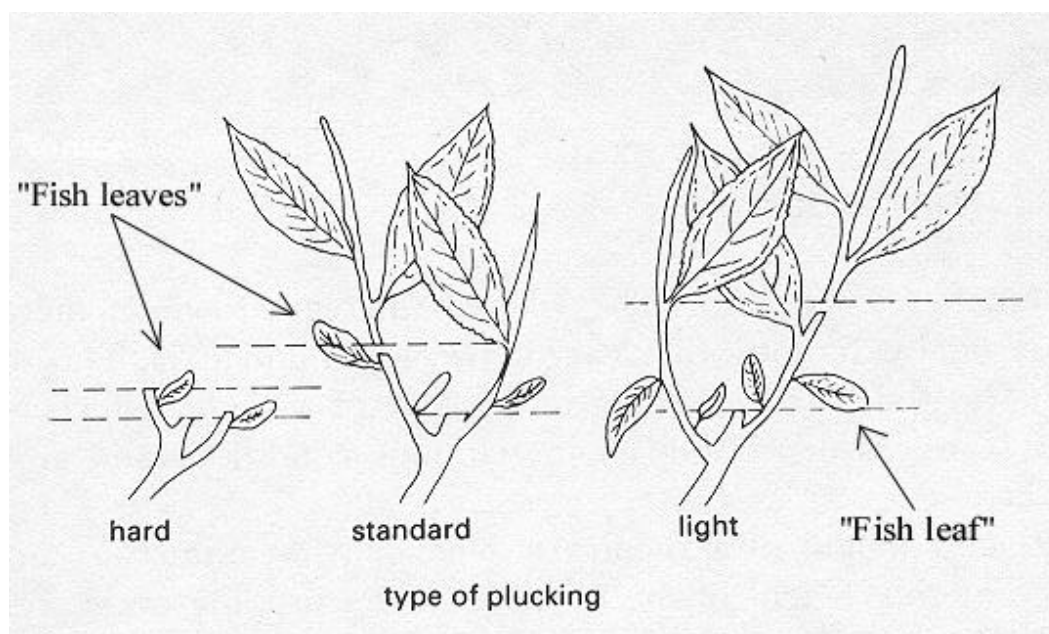
Sleeping "banjhi" bud



***If they are above the plucking table, both actively-growing and "banjhi" shoots should be plucked.*** Source: original drawings by Wendy Gibbs.

In Viet Nam, some farmers always pluck the shoot just above the rounded "fish leaf", harvesting all the leaves above the fish leaf and harvesting the bud (see drawing on next page). However, the Tea Research Institute recommends using different plucking heights according to the season:

- **For spring harvest**, the tea has recently been pruned. Therefore, we need to spare more leaves so that the plant can produce the energy that it needs to recover from the stress of pruning. So, **pluck only when the shoots are tall enough to allow plucking the "shrimp leaf" plus 2-3 young leaves, leaving behind on the bush two real leaves plus the fish leaf.**
- **For summer-autumn harvest**, the tea bush has by now developed a good leaf system. If we leave too many leaves on the bush, they may shade each other. Also, if we leave too many leaves unplucked, after each plucking, we will have to wait longer for the next plucking, thus reducing yield. So, we should pluck more often (pluck younger, shorter shoots) than during the spring. **Pluck all shoots that are tall enough to allow plucking the "shrimp leaf" plus 2-3 young leaves, leaving behind on the bush one real leaf plus the fish leaf.**
- **For winter harvest**, at year-end, the climate is not favorable (temperature and humidity are both low). Tea buds are growing slowly, so we should pluck them as soon as they are ready; otherwise the buds will get old, reducing yield and quality. We don't need to worry so much about leaving behind enough leaves for the bush, because we will soon prune the bush and those leaves will be lost anyway. Therefore, pluck any shoots that are above the plucking table. **Pluck just above the fish leaf or even pluck the fish leaf, leaving behind on the bush only the fish leaf or no leaves.**



***Types of plucking, relative to the fish leaf.***

*In Vietnam, TRI recommends changing the type of plucking according to the season. Farmers in some countries always pluck above the first true leaf, or may even pluck below the fish leaf! Source: adapted from Bonheure, D. 1990. Tea. In the series entitled The Tropical Agriculturalist. Maissonneuve et Larose, Paris.*

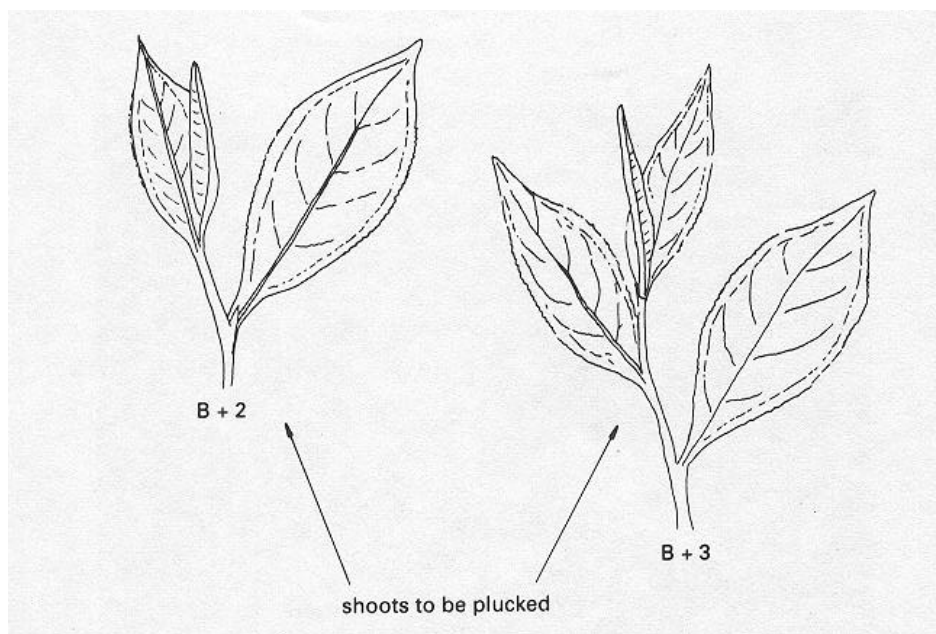


### **What to pluck: recommendations from other countries:**

Some tea-growing countries recommend plucking lower, below the fish leaf but above the “janam”. Other countries recommend plucking higher, above the first true foliage leaf (see drawing). Some researchers even recommend alternating a few years of fish-leaf plucking with a few years of one-leaf plucking. Because farmers are using so many different systems, the only thing we can recommend to farmers in Viet Nam is: do your own experiments. Remember, because tea is a long-lived crop, plucking experiments should measure long-term effects and not just yields from a single year.

### **What to harvest**

Only the bud and the two (or at most three) youngest leaves are tender and green enough for high-quality tea. If the plucked shoot includes any older leaves or stem, these should be broken off and left in the field. If this is not done (in other words, if the shoot is plucked closer to the tip, leaving several leaves above the fish leaf), the height of the flat canopy will increase too quickly.



***Harvest only the bud (the rolled "shrimp leaf" or the banjhi bud) plus the youngest two or three open leaves.***

*Source: adapted from Bonheure, D. 1990. Tea. In the series entitled The Tropical Agriculturalist. Maissonneuve et Larose, Paris.*

Harvesting older leaves (bud + 3 leaves) will reduce quality. The third leaf has substantially less tannin and less soluble contents than the second leaf. But at the same time, harvesting the third leaf will increase the weight of the harvest. So, is it profitable to harvest the third leaf? You already know the answer: do an experiment and find out! In one sao, harvest only shoots with (bud + two leaves) shoots. In another sao, harvest (bud + three leaves). Compare the prices you receive from the two sao. And, compare the taste (quality) of the tea.



For experiments on plucking, use study #4 from the Tea IPM Field Guide as a guide (study entitled “**Effect of different plucking methods on tea ecosystem and production**”). If you are just comparing two different bud sizes, there is probably no need to sample pests and natural enemies.

During plucking, be careful not to bruise or crush the leaves. This will reduce quality. For example, do not compress (pack down) the leaves in the plucking basket.

**How many times to pluck:**

There are two popular systems for plucking. One system is to pluck only once every 45 days, harvesting most of the buds. The second system is to pluck as soon as about 30% of the buds are ready for harvest (in other words, pluck about every 10-15 days). Each system has its advantages and disadvantages, as shown in the table below. So, farmers should do experiments to decide which system is best for them.

**Advantages and disadvantages of two popular plucking systems:**

Plucking system	Advantages	Disadvantages
Pluck every 45 days, harvesting most of the shoots on the tea plant	Takes less <b>labor</b> (only have to go to field 7 or 8 times per year)	Tea <b>yield</b> will be lower than if you plucked every 10-15 days
	Simpler to <b>organize</b> (fewer dates on which you must schedule your labor force)	Tea <b>quality</b> will be lower than if you plucked every 10-15 days
		Does not help reduce <b>damage from insect pests</b> (because shoots remain on the tea plant longer, insects eggs have time to hatch and young insects have time to grow)
Pluck every 10-15 days, harvesting only the shoots that are ready (about 30% of the shoots on the tea plant)	Tea <b>yield</b> will be higher than if you only plucked every 45 days	Takes more <b>labor</b> (must go to the field 15 to 20 times per year)
	Tea <b>quality</b> will be higher than if you only plucked every 45 days	More complicated to <b>organize</b> (more dates on which you must schedule your labor force)
	Helps reduce <b>damage from insect pests</b> (plucking every 10-15 days removes insect eggs and young insects before they can grow large enough to cause a lot of damage)	

There is one criterion that is not in the table: the **long-term health** of the tea bush. The reason is, we don't yet know which of the two plucking systems is best for the long-term health of the plant. Therefore, farmers should conduct long-term experiments to answer this question.



For experiments on long-term effects of plucking, continue study #4 from the Tea IPM Field Guide for several years (study entitled “**Effects of different plucking methods on tea ecosystem and production**”). Do not carry out weekly sampling. After each harvest, observe plant height, color, and health; and measure yield and quality of tea. At the end of the study, compute economic benefits.

### **Which plucking system should I use?**

There is little doubt that “fine” plucking (plucking every 10-15 days) increases yield and quality. This was proven in an experiment by tea farmers in Thanh Ba District, Phu Tho Province in 1997, and by a second experiment during the TOT training in Phu Tho in 1999. In both experiments, fine plucking required much higher labor costs. Nonetheless, it gave much higher profits, because tea yield and quality were so much higher. Fine plucking increased yields by 23% in Thanh Ba and by 22% in the Phu Tho TOT.

But: high tea profits are not the only goal of tea farmers. For example, a farmer might choose to accept lower profits from his or her tea, and invest some of his or her labor in other activities. No single plucking system will satisfy the needs of every farmer.

### 6.3.9 Pruning

During the commercial stage, the purposes of pruning are:

1. To encourage tea trees to grow plenty of new leaves, instead of shifting into reproductive growth stage (producing flowers and fruits).
2. To increase the number and size of growing buds.
3. To keep the frame of the tea bush within easy reach of the pickers.
4. To replace old and diseased branches with strong, healthy ones.

The tools and procedures for pruning are the same as were discussed in branch formation stage (above).

### **How often should you prune?**

Note that, once the tea has reached commercial stage, the schedule for pruning is the same for bushes grown from seeds or from cuttings.

Most farmers in Viet Nam prune every year. But, farmers in other countries follow different systems. The following is the recommendation of the Tea Research Institute:

## Light prunings

Year 4: The final formation pruning (to shape the main frame of large branches). Prune the bush 40-45 cm above the ground. This was already mentioned in Section 6.2 (above).

Years 5 and 6: At the end of each year (mid-December-February), cut only the green wood. Cut at a height 5 cm above the height of the previous pruning. For example, if at the end of Year 4 you pruned to 40 cm, then in Year 5 you should prune to 45 cm and in Year 6 to 50 cm. Each year, you should also prune any branches at the base of the main stem.

Years 7-11: At the end of each year, cut the green wood 3 cm higher than the previous year (for example, 53 cm, then 56 cm, etc.). Each year, you should also prune any branches at the base of the main stem.

When the frame of the tea bush reaches a height of 70 cm (approximately Year 12), prune only 1-2 cm higher each year.

The general appearance of a bush after light pruning is shown in the following photograph.



***Yearly light pruning during the commercial stage. Contrary to TRI recommendations, the highest edge of the pruning cuts is not always facing towards the outside of this bush.***  
*Source: original photograph by Michael Zeiss.*

After years of this light annual pruning, you will start to notice the following problems:

- Tea bushes have grown so tall that they are out of reach of the pickers (studies have shown that, for pickers who are 1,3 meters tall, the most efficient tipping height is 80 cm above the ground).
- Crown buds are abundant, but are very small.
- Tea yields are declining.

When this occurs, tea should be given a medium pruning.

## **Medium prunings**

Prune the tea tree 55-60 cm above the ground. Some major branches should be cut to stimulate dormant buds to produce new branches for a healthier and younger canopy. Especially, branches that are dead, diseased, or crossing should be removed. The following years, return to light prunings.

## **Heavy pruning**

After many years of light and medium pruning, tea often becomes somewhat degraded and weak. Tea branches have many bends and kinks (are not straight), and there are a number of rotten buds. When this occurs, tea should be pruned heavily 40-45 cm above the ground. After heavy pruning, tea must be carefully tended until it recovers. Even with good tending, yields often drop for 1-2 years after heavy pruning. Once bushes recover, return to light prunings.

## **Pruning recommendations from other countries**

As for plucking, tea farmers in different countries follow different pruning systems. In many countries, light pruning is not done every year. There are at least two other systems used by tea farmers:

1. In some countries, the flat top of the canopy ("plucking table") is allowed to rise 5-10 cm per year. This rise is the height of the plucked shoots that remain on the bush (from the base of the shoot up to the fish leaf). Pruning is done only when the plucking table gets too high for the pickers. Farmers should prune every 2-6 years depending on the climate, the tea variety, and the type of plucking (fish leaf, first leaf, etc.)
2. In much of India, pruning is done only every 3 years. The first year, the bush is pruned, with the height of pruning about 2,5 cm above the previous pruning level. The second year, the bush is "skiffed". Skiffing means cutting only green wood, at a height about 15 cm above the pruning height (just below the "crows feet" that are formed by plucking). The third year, the bush is neither pruned nor skiffed. This 3-year cycle has increased yields compared to the old annual pruning system. But, the new system can make tea more susceptible to drought, because more leaves remain on the bushes early in the year.

Would either of these systems be productive in Viet Nam? Only experiments will give the answer. And, of course, no single system of pruning will be suitable for every farmer; each farmer will have to consider how much labor he or she has, what other activities (besides tea) he or she needs to do, etc.

## **In what month should you prune?**

For most farmers, the best time for pruning is from mid-December to February (before the Tet holiday). However, some farmers prune after Tet (see box on the next page). In early April, after pruning but before plucking, the bushes should be "tipped" by hand to create a flat canopy. This was already discussed in the "plucking" section, above.



## When is the best time to prune?

It depends on the goals of the farmer.

For the long-term health and yield of the tea, the best time is from mid-December to January (before the Tet holiday). During this time, the tea has stopped growing new shoots. Therefore, it has energy (starch) stored in its roots. This is important, because the tea bush needs a good supply of energy to recover from pruning (to grow new shoots and leaves). So, if your goal is to have a long-term income, prune in December- January. Your tea bushes will probably live longer and be more resistant to disease.

But, for farmers who live near a city (such as Thai Nguyen City), it might be more profitable to wait until after Tet to prune. The reason is, this allows them to harvest and sell tea right before Tet, when the price of tea can be 3 times higher than the rest of the year. Pruning after Tet is stressful for the bushes, for two reasons. First, the bushes have many leaves early in the year, and therefore need more water (may be susceptible to drought). Second, it is stressful for the bushes to recover from late pruning. Their roots have already used much of their stored energy to produce shoots and leaves during the winter and spring. Because of these two stresses, the bushes might be more susceptible to disease or might not live as long. But even if the bushes die a few years early, some farmers might make more money by pruning late.

Is anyone experimenting with alternating between the two pruning dates? Write us a letter about your results.

## **6.4 Managing degraded tea**

Some old tea fields start to show the following problems:

- low yields
- increasing number of empty spots due to death of weak bushes
- branches become thin and diseased
- increasing rate of diseases of the top and of the roots
- depletion of soil nutrients
- increase in the proportion of unproductive (brown and woody) tissues on tea plants
- buds and crown buds are small and scarce
- many shoots at the base of the bush, or sprouting up from the soil

This combination of problems is often called degraded tea. Sometimes the name "ageing tea" is used. However, the problem is probably caused more by bad management than by actual age. This is shown by the fact that some plantations planted in 1958 are still healthy and productive.

Degraded tea can be managed with a combination of practices, called rejuvenation, which can stop the deterioration and improve the yielding capacity of a degraded field. Rejuvenation includes:

1. low pruning, to remove as much of the unproductive bush frame as possible
2. removing any remaining diseased and damaged parts of the bush
3. removing and replanting dead or unproductive bushes
4. improving soil to favor quick re-growth of shoots and of feeder roots.

Before rejuvenating a degraded field, first you need to decide if it would be better to uproot and replant it (see Chapter Five). Rejuvenation may raise yields by 10-25% by the seventh year after heavy pruning. But uprooting and replanting with high-quality transplants will probably increase yields much more. Further, rejuvenated fields will not retain their economic viability for long, whereas a replanted field will remain productive for decades. In general, it is better to uproot (rather than rejuvenate) fields that are heavily infected with root diseases, or that have more than 30% missing bushes.

Besides long-term benefits, another consideration is cash-flow in the short term. It takes years before an uprooted and replanted field repays the cost of replanting. The payback period for rejuvenation is shorter. Nonetheless, even a replanted field will start generating income 3 years after uprooting and replanting. And one experiment on rejuvenation during the 1999 TOT training in Phu Tho found that only 8 months after rejuvenation, the rejuvenated portion of the field was already yielding more than before rejuvenation.

Each farmer will have to evaluate the potential profitability of replanting versus rejuvenating, and will have to evaluate his or her need for short-term income.

Finally, note that a tea bush should receive rejuvenation pruning only once. If a field has already received rejuvenation pruning, but has again become degraded, it is better to uproot and replant it.

#### 6.4.1 Steps in rejuvenating

1. If it is necessary to remove any old shade trees, they should be bark-ringed at least 2 years before pruning the tea bushes (see Chapter Five).
2. During the year you are planning to prune, apply fertilizer, manure, and compost as recommended for commercial stage tea. Stop fertilizing 5-6 months ahead of pruning (by July or August).
3. Stop plucking by mid-October to “rest” the field for 6-8 weeks before pruning. This allows the roots to build up their supply of energy.
4. In mid-December to January, “skiff” the bushes (cut the green wood about 10 cm below the flat canopy). All leaves and green wood should be left in the field as a source of green manure. Mark any bushes that are so weak and unproductive that they need to be removed.
5. Immediately after skiffing, cut the bushes back to a height of 15-20 cm above the soil surface. The idea is to stimulate the buds close to the base of the trunk, to generate a completely new canopy. Some experts recommend leaving 3-4 branches unpruned on each bush, to act as “lungs”. The leaves on the “lungs” help maintain the energy supply of the plant, and help draw in more nutrients and water into the plant. However, other experts say that “lungs” slow the regrowth of new shoots, and are not necessary.
6. Dig up and remove any dead or unproductive bushes (those that you marked during step #4). Remove as much as possible of the root system. If the bush was infected with root rot, remove as much soil as possible. Treat the hole with lime and wood ashes to help kill the root rot remaining behind.
7. On each healthy bush that remains, cut out all dead and dying branches down to healthy wood. In some cases, it may be necessary to cut down to the collar region and scoop out dead tissues from the junction of branches near the collar. Remove all cut woody branches from the field.
8. Repair any drainage, terraces, or soil conservation measures in the field. Then, level the ground to prepare for replanting missing bushes.
9. Replant each missing bush with 2 or even 3 strong seedlings. The reason is, the growth of the seedlings will be restricted by the surrounding mature bushes. Use plenty of compost in the planting holes to help the seedlings resist root rots, and consider treating the soil with *Trichoderma* (see Section 11.4). If shade trees are needed (such as “muong la ngon” trees within the rows), they should be planted at the same time as the transplants.
10. Care for the field as if it were a seedling-stage field (see Section 6.1, above). Careful tending is essential for bushes to recover from the heavy pruning. In particular, it is recommended to plant green-manure crops such as “cot khi” between the rows to improve the soil. Take special care of the newly planted seedlings (mulch, watering if necessary, etc.).
11. In future years, when pruning the new seedlings, prune higher above the soil than usual, to permit them to compete with the mature bushes. The seedlings will therefore produce narrow frames with fewer shoots; it is for this reason that you should plant 2-3 seedlings for each missing bush. It may also be necessary to trim the side branches of the mature bushes around the seedlings, to provide room for the growth of the seedlings.

The heavy pruning usually sharply reduces tea yields for a few years. However, an experiment on rejuvenation during the 1999 TOT training in Phu Tho found that only eight months after rejuvenation, the rejuvenated portion of the field was already yielding more than before rejuvenation.