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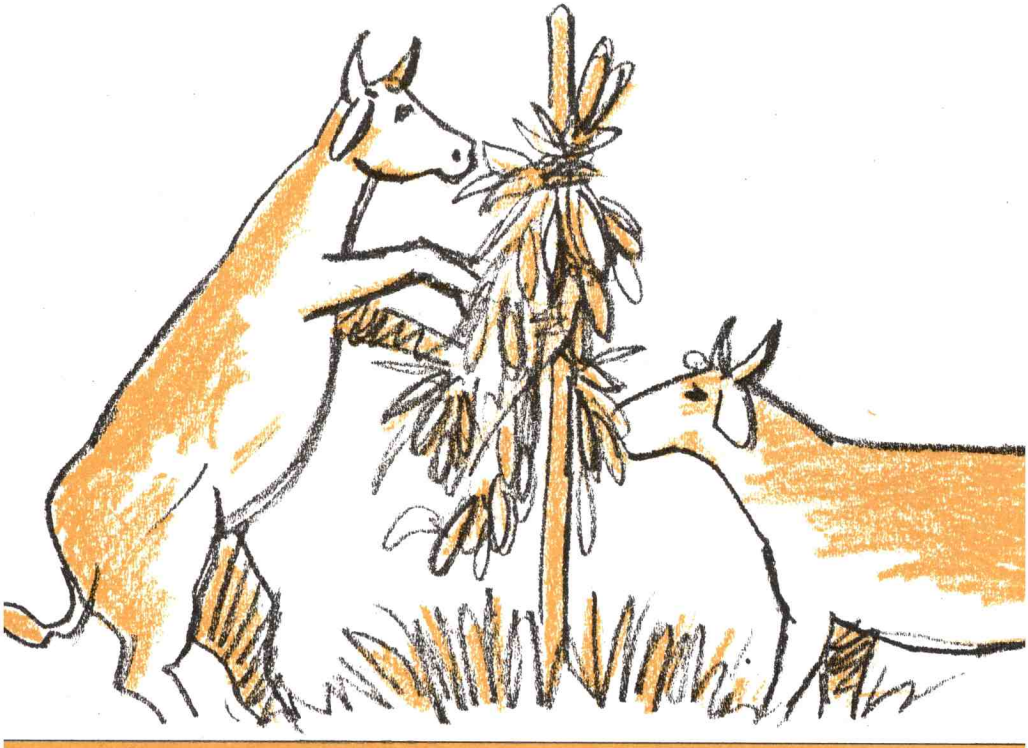
using fodder from trees and shrubs to feed livestock in the tropics



FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

BETTER FARMING SERIES

The titles published in this series are designed as hand-books for intermediate-level agricultural education and training courses. They may be purchased as a set or individually.

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36. Raising rabbits 1: learning about rabbits; building the pens; choosing rabbits
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39. Raising ducks 1: how to begin
40. Raising ducks 2: further improvement; a larger flock
41. Raising ducks 3: further improvement; taking care of a larger flock
42. Using fodder from trees and shrubs to feed livestock in the tropics

better farming series 42

using fodder from trees and shrubs to feed livestock in the tropics

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PREFACE

The first 26 volumes in FAO's Better Farming Series were based on the **Cours d'apprentissage agricole** prepared in Côte d'Ivoire by the **Institut africain de développement économique et social** for use by extension workers. Later volumes, beginning with No. 27, have been prepared by FAO for use in agricultural development at the farm and family level. The approach has deliberately been a general one, the intention being to create a basic model that can be modified or expanded according to local conditions of agriculture.

Many of the booklets deal with specific crops and techniques, while others are intended to give farmers more general information that can help them to understand **why** they do what they do, so that they will be able to do it better.

Adaptations of the series, or individual volumes in it, have been published in Amharic, Arabic, Bengali, Creole, Hindi, Igala, Indonesian, Kiswahili, Malagasy, SiSwati, Thai and Turkish. This volume has been prepared by the FAO Animal Production and Health Division (Dr P.L. Pugliese).

Requests for permission to issue this manual in other languages and to adapt it according to local climatic and ecological conditions are welcomed. They should be addressed to the Director, Publications Division, Food and Agriculture Organization of the United Nations, Viale delle Terme di Caracalla, 00100 Rome, Italy.

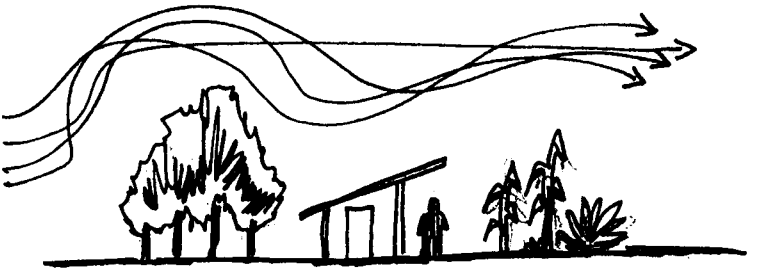
Booklets 27 to 41 in the FAO Better Farming Series were written and illustrated by Tom Laughlin, working closely with the technical divisions concerned.

OUTLINE OF THE MANUAL

INTRODUCTION

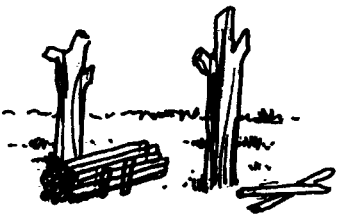
1. Trees and shrubs play a number of very important roles for people and their livestock. The whole tree provides shade,

serves as a windbreak



and controls soil erosion.

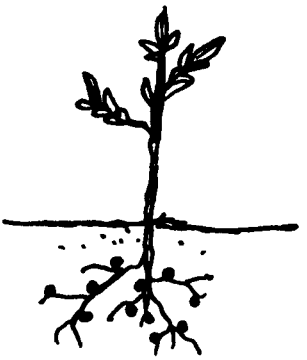
2. The various parts of the tree also play special roles. Stems and branches give us



fuelwood, and timber,

while roots, leaves, flowers and bark are used as drugs.

3. Also, some trees, known as leguminous trees, improve the soil by fixing nitrogen from the air, making it available to livestock.



4. For livestock farmers, the tree's most important role is the use of leaves, flowers, tender twigs, seeds, fruits and pods as feed or fodder for the animals, and food for the farmers themselves.

5. In dry tropical areas where rainfall is low and therefore grasses for feeding animals are seasonally scarce and low in quality, you can sometimes feed your animals almost entirely on fodder trees. Even in the wetter areas where rainfall is high, and plenty of grass is available most of the time, you should still feed tree fodder to your animals, because fodder from trees contains important feed items (nutrients) that grasses sometimes do not have.

6. Animals fed tree fodder together with grasses will therefore be healthy, and grow faster than those that are fed only on grasses.

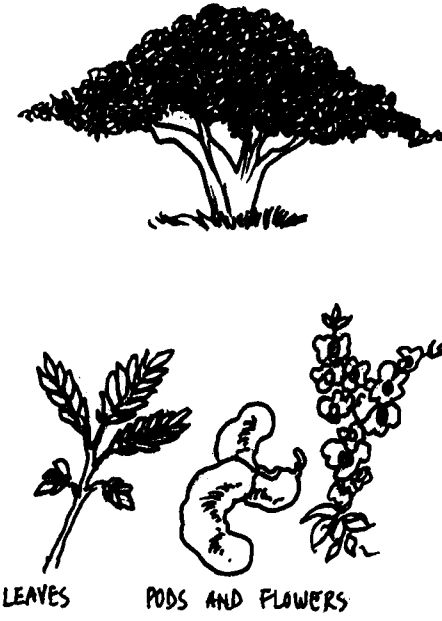
7. We shall later describe how to grow these trees and how much of the tree fodder has to be fed, either alone or with grasses, to ruminants such as cattle, sheep, goats and buffaloes, and to non-ruminants such as pigs, poultry and rabbits.

SOME COMMON FODDER TREES AND SHRUBS

8. First let us describe some of the fodder trees and shrubs that farmers can use to feed their animals. Take note of important characteristics such as the type of soil and climate (semi-arid, subhumid, humid) in which these trees and shrubs grow best, so that you can choose suitable ones for your particular area and soil conditions.

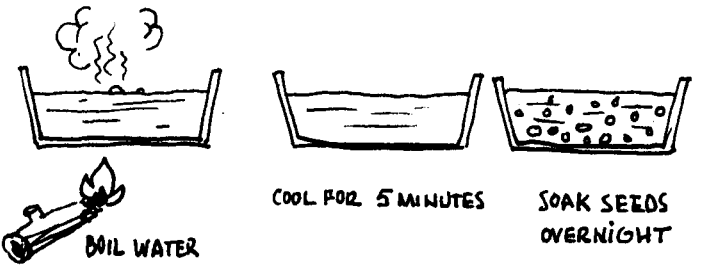
Faidherbia albida (Acacia albida)

9. This tree grows very well in dry areas with 400-500 mm of rainfall per year. You can plant it in sandy, clay, shallow rocky soils; it generally grows well in deep and light soils.

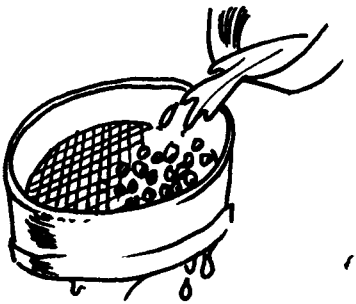


10. Plant 3-4 seeds at the beginning of the rains in well-prepared spots in your field, about 10 metres apart, so you can have 70 or more trees per hectare.

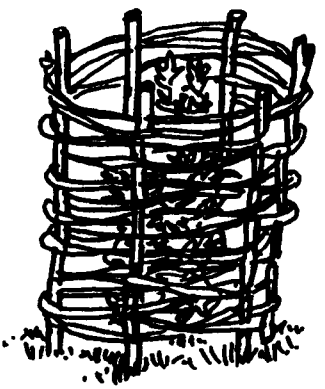
11. In order to get the seeds to germinate quickly in 14-28 days, you need to treat them with hot water. Boil some water, cool it for 5 minutes and then soak the seeds overnight, using at least three times more water than seeds in order to cover the seeds completely. (Some agronomists also recommend mechanical scarification which they consider to be safer under semi-arid conditions.)

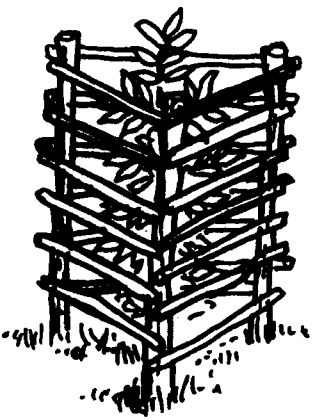


12. The following day, pour the water away, and plant the seeds immediately.



13. The tree grows rapidly and may be as tall as 2 metres in the first year, but you need to weed regularly and protect it from animals during this time.





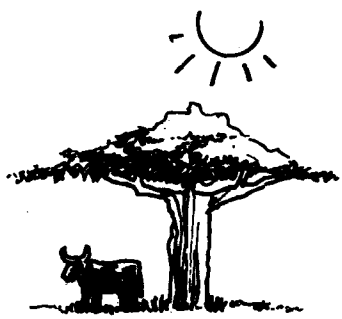
14. The adult tree

produces

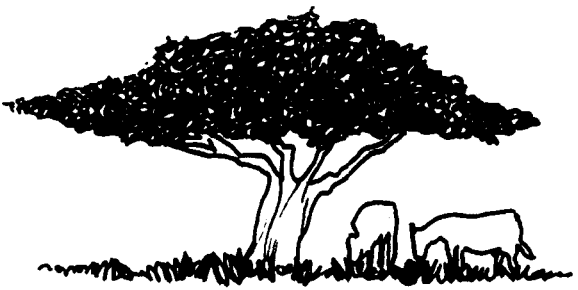
green fodder but, most important, 130 kg pods

(and sometimes more) every year. These are particularly suitable for feeding your livestock.

15. Another good thing about the tree is that it starts to shed its leaves at the beginning of the rains, when crops are planted. The crops then receive nitrogen from the leaves that have fallen and will produce well.

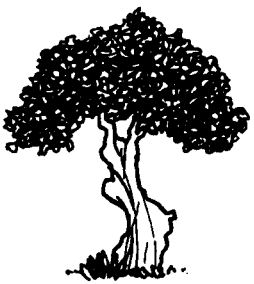


16. The leaves grow again during the dry season to give shade and feed to your animals.



Acacia tortilis

17. This tree spreads like an umbrella, and is known as the umbrella thorn.

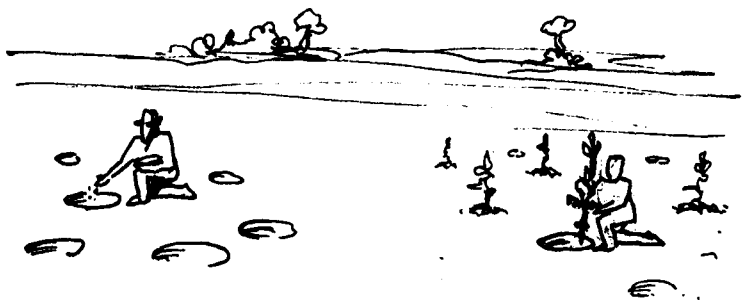


18. Farmers in dry and semi-arid areas can plant this tree for shade and feed, because it is very drought-resistant and is able to grow even where rainfall is very low. For example, you will find it in many of the countries that border the Sahara desert. It likes alkaline soils, but also grows in saline soils.

19. To plant it, first obtain seeds from the pods by pounding them in a mortar and cleaning off the chaff.

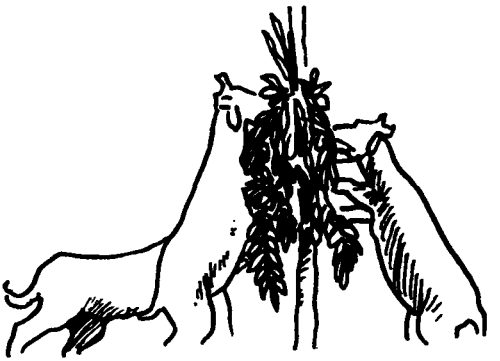
20. Then prepare the seeds either in the same way as *Faidherbia* (using hot water) or by shaking the seeds in a can into which holes have been punched.

21. You can then plant the seeds directly in the field in 1-cm-deep holes or by using 3-8-month-old seedlings raised in your nursery. Do not expose roots to direct sun.



Albizia lebbeck

22. You can feed the fodder from this tree to your animals in large quantities because it has no toxic compounds and animals will readily eat it.

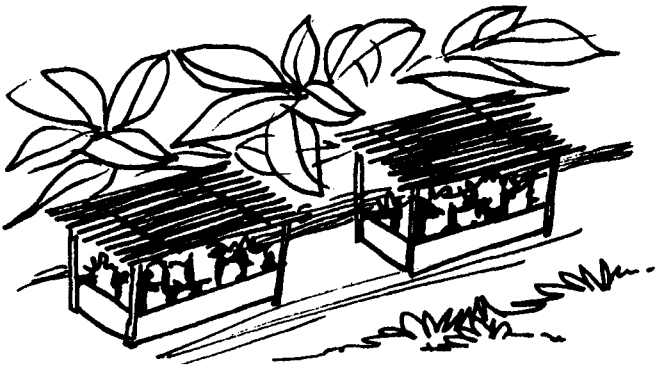


23. This tree grows in dry areas with little rainfall (600 mm/year), sometimes in the form of a shrub with many branches,

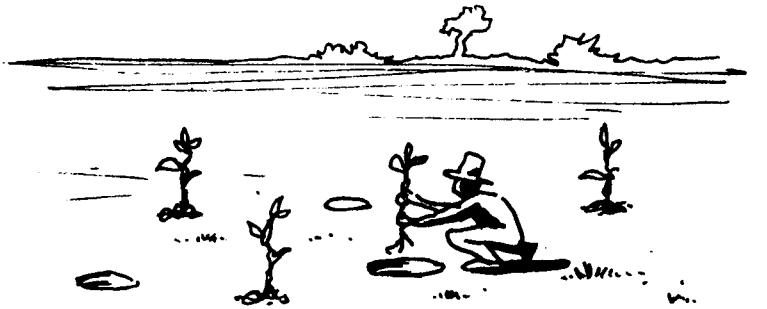
or in wet areas (2 500 mm/year) as a tree.

24. You can plant it from seeds in acid, alkaline or saline soils, directly in your field,

or first in a nursery,



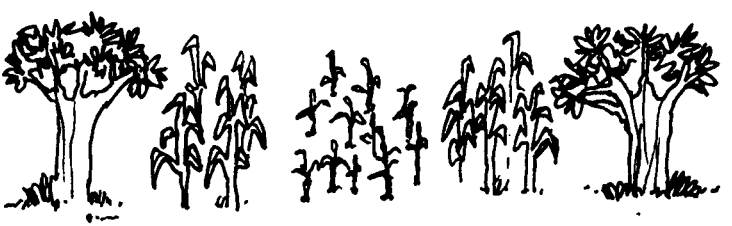
and then transfer it to the field after about four months.



***Cajanus cajan* (pigeon pea)**

25. Pigeon pea can be grown nearly everywhere, from the dry Sahel to the subhumid wooded savannah and the humid forest areas, but you should use the types that are suitable for your particular area.

26. It can be established by direct seeding in well-prepared fields; the seeds need no treatment before planting. You can plant pigeon pea with cereals such as sorghum and millet or with short-duration grain legumes such as cowpea (*niébé*, *Vigna unguiculata*).



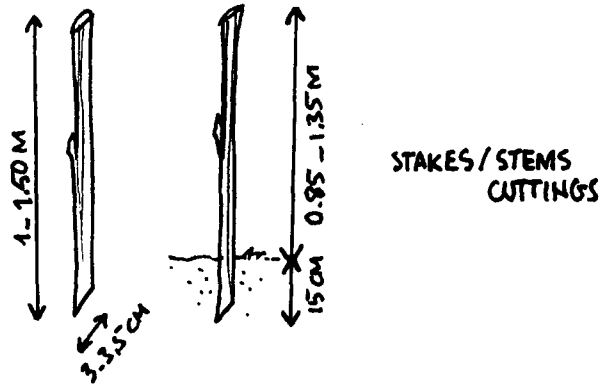
27. The fodder produced is of good quality; you can feed it to your livestock together with grasses or your crop residues. The plant does not like shade and does not live long. You may have to replant it every two to three years, but never replant it on the same site because of possible serious root diseases.

Gliricidia sepium

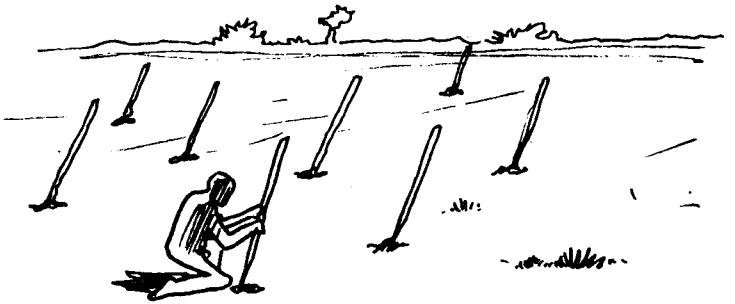
28. This is a very common fodder tree found in many parts of the tropics, where it is known by different names, such as *mataratón* (rat killer) or *madre de cacao* (mother of cocoa).

29. It grows best in wet and warm weather conditions where rainfall is over 800 mm per year. It can be grown in different types of soil – acid, alkaline or even in soils containing some clay.

30. You can grow *Gliricidia* from seeds or stem cuttings. If you use stem cuttings, make sure they are taken from plants over six months old, and that they are about 1.5 m long and 3-5 cm in diameter.



31. Plant the stems within three days after cutting at a depth of about 15 cm.



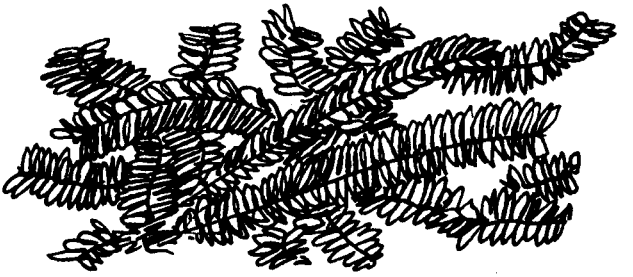
32. If planting from seeds, soak the seeds overnight in hot water before planting. Sheep and goats like to eat this plant and they can be fed a lot of it without any problems of toxicity. Sometimes your cattle may refuse to eat *Gliricidia* if you give it to them as soon as you cut the leaves. However, they will eat the leaves if you dry them in the sun for two to three hours before feeding the animals.

33. If you take proper care of the plant by cutting it at regular intervals, as will be described in another section, you will get a lot of green feed for your sheep and goats even during the dry season.

Leucaena leucocephala

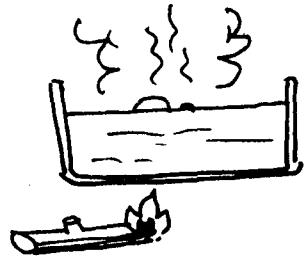
34. This tree is found in nearly all tropical countries where it is known by different names, such as *lamtoro* in Indonesia, *ipil-ipil* in the Philippines, and *guaje* in Mexico. Three main types of *Leucaena* are available for planting.

35. The giant or arboreal type, also known as Guatemala or Salvador type, can reach up to 20 metres; the Peru or Cunningham type has many branches and can reach about 15 metres; the common bushy or Hawaiian type is the shortest: about 5 metres. The giant and Peru types are recommended because they produce a lot of fodder.



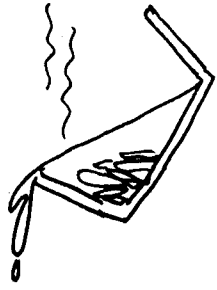
36. *Leucaena* grows well in areas where rainfall is between 1 200 and 2 000 mm. It does not like soils that retain too much water, so it grows best in well-drained soils that are preferably alkaline. It does not like acid soils. Areas with about 1 500 mm of rain, four months of dry season and alkaline soils are the best for growing *Leucaena*.

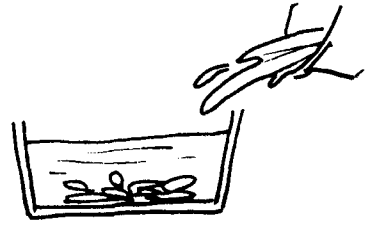
37. *Leucaena* seeds are very hard, so they must be treated before planting.



Boil water:

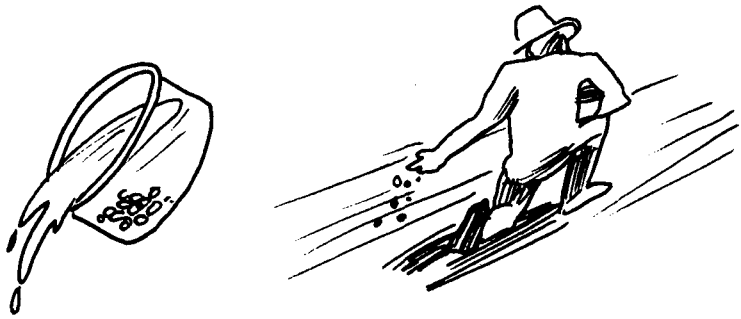
pour it on the *Leucaena* seeds, using three times the amount of water to the amount of seeds, and stir the seeds for about five minutes:





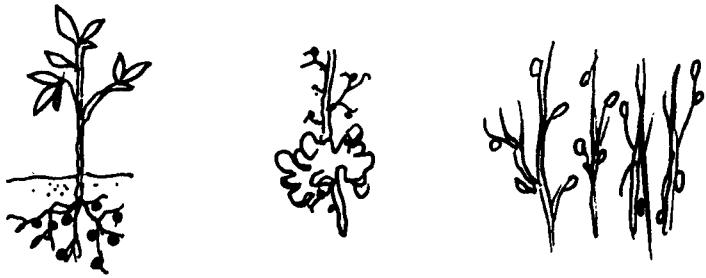
then pour the hot water away, and add cold water to cool down the seeds.

Drain out the cold water and plant the seeds immediately. If you cannot plant immediately, dry the seeds and store them for later planting.



38. *Leucaena* as a legume is able to transform the nitrogen gas existing in the air into nitrogen compounds that can be used by the plant itself; therefore it grows well without fertilization in soils that are poor in nitrogen.

39. This change of nitrogen gas to nitrogen compounds is known as nitrogen fixation; it is done by bacteria called rhizobia that live on the roots of *Leucaena*.



40. When you plant *Leucaena* for the first time in your field, the rhizobia may not be present, so you have to inoculate the seeds with the rhizobia. To do this, you rub the rhizobia on the seeds so that when they germinate, the rhizobia on the roots can then fix nitrogen. We shall describe how to inoculate seeds later in another section.

41. *Leucaena* leaves are very palatable but they also contain a toxic substance called mimosine which can harm your animals if they eat too much of it. You will find out in the next section in what form and how much of *Leucaena* you can feed your animals to avoid harming them.

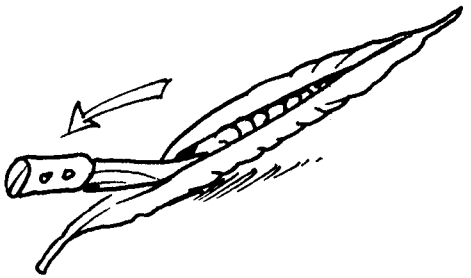
Prosopis juliflora

42. This plant is most suitable for dry arid regions with an annual rainfall of about 500 mm or even less. It is one of the few trees that will grow well in areas where rainfall is uncertain and low (250-350 mm). It grows and remains green all year round, and does well in almost all types of soils, including rocky, acid and alkaline soils.

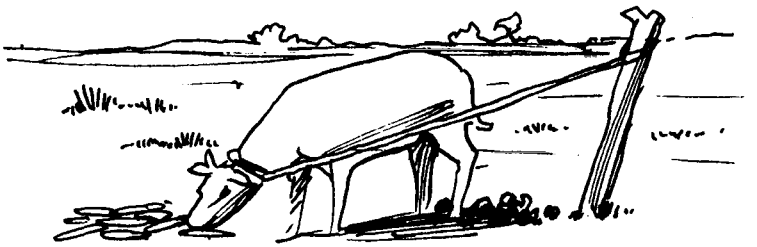
43. This plant, also known as mesquite, is grown from seeds. These seeds are embedded in hard pods.

44. The first step is to remove the seeds from the pods. You can do this in any of the following ways:

- cut the pod with a knife lengthwise and separate the seeds inside. This takes time and is not suitable if you need a lot of seeds;



- feed the pods to animals and collect the seeds that come out free and intact in the animal faeces, ready for planting; however, the animal has to be tied down to collect the seeds;

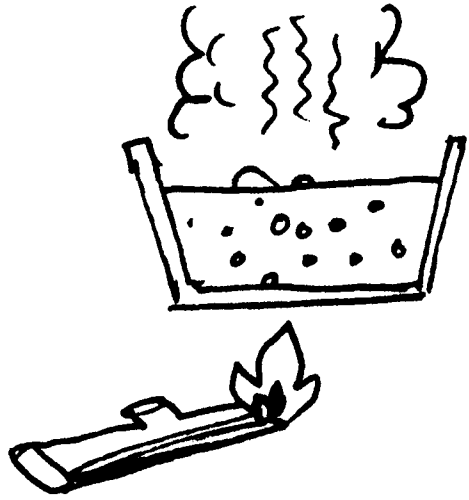


- sun-dry the pods and pound or mill them to separate the seeds;

- the pods can also be treated with chemicals such as hydrochloric acid and sodium hydroxide to free the seeds; this method is expensive and dangerous because the chemicals are harmful.

45. After getting the seeds out of the pods, you need to treat them to improve germination because, like *Leucaena* and some other plants, the seeds have a tough coat that prevents water from entering to start the germination.

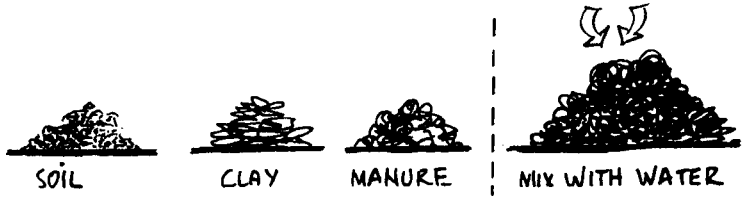
46. You can soak the seeds in water for six to ten hours; you can also boil water and then put in the seeds and continue boiling for about five minutes.



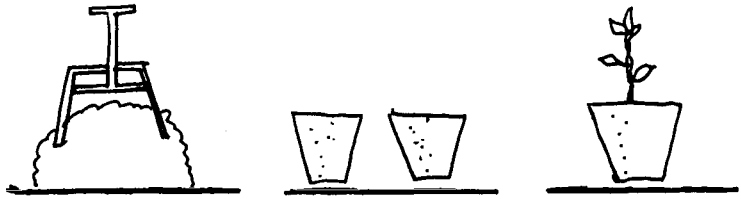
47. Then remove the seeds from the water and plant immediately. You can plant the seeds directly in the soil or in "torrões paulistas" (see further on).

48. For direct seed planting, make sure the field is well prepared and well watered, otherwise the seeds will dry out. Watering is very important if you do not plant during the rains.

49. Prepare for planting in "torrões paulistas" – which is soil, clay and manure moulded in the form of a pot – by mixing two parts of soil, two parts of clay and one part of manure, adding water until you obtain a semi-solid paste.



50. Leave the paste to settle and dry for a day, then cut it out in the form of a pot, let it dry and use when needed. (You can also use, as in Thailand, one part of soil, one part of sand and one part of rice husk ashes.)



51. When the seedlings germinate and reach a height of about 20 cm, plant them in the field by digging a pit and placing the "torrõa paulista" with the seedling in the pit.

52. It is best to plant at the beginning of the rains so that the growing seedlings will have enough water and survive the following dry season.

53. *Prosopis juliflora* is a good fodder tree that grows rapidly and starts producing a lot of pods from the second or third year. You can feed the pods to all classes of livestock either alone or with other feeds. Read the next section to see how you can use the plant to feed your livestock.

54. The leaves, tender shoots, flowers, pods and seeds of all these trees and shrubs can be fed to ruminants (cattle, buffaloes, sheep and goats) and to non-ruminants (pigs, rabbits and poultry). They contain high levels of protein and some important minerals like phosphorus (P) which make your animals grow rapidly. (See table.)

Average percentage of dry-matter content

(%)	Protein	P	Fibre
Leucaena[a]	22	0.12	20
Gliricidia[a]	23	0.20	21
Mesquite[b]	36/14	0.20	6/28
Pigeon pea[a]	23	0.20	30

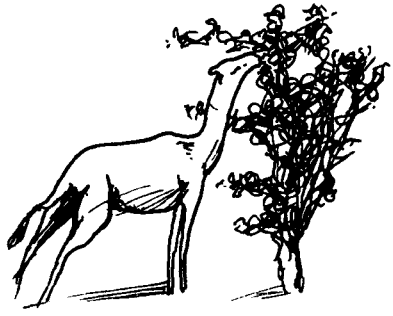
[a] Green leaves and shoots. [b] Seeds/pods.

55. They also contain high levels of fibre (see table). This rapidly fills the stomachs of pigs and chickens, so these tree fodders are more suitable for cattle, sheep and goats than for non-ruminant animals.

56. Some tree fodders contain toxic compounds and so you should not feed a lot of this type of fodder to any animal, including cattle, sheep and goats.

57. How much tree fodder can you feed to your livestock, and should you feed them green, fresh or dried?

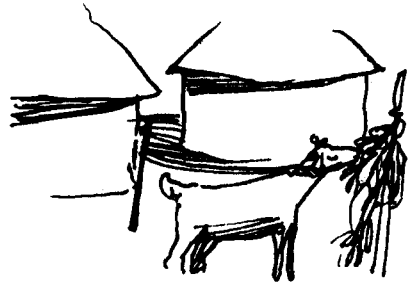
58. The easiest way to feed the fodder is to let your cattle, sheep, goats or camels browse directly on trees in the range, in fallow land or in your backyard, if the trees are not too tall.



59. If the trees are too tall, you may have to cut the branches

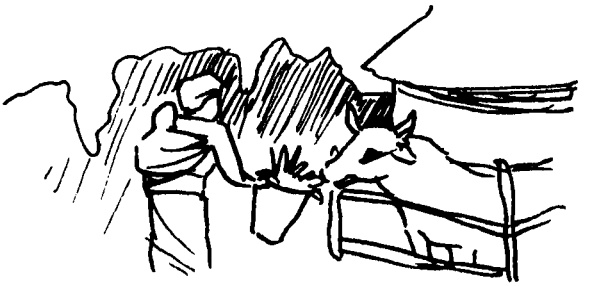
and carry them to your animals to eat

in the field,



in your backyard,

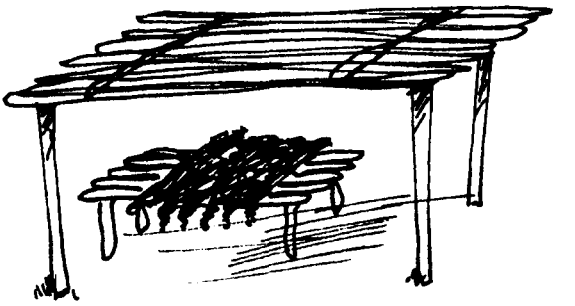
or in the stall.



60. In this way, your animals will eat fresh leaves and small stems. Goats will sometimes eat the bark of large stems and this is also good for them.

61. Another way is to feed dry forage. Cut it and dry it in the sun for a few days,

then store it for feeding later on.



62. It is in this dried form that you should feed the fodder to pigs and chickens. After sun-drying, crush or grind the leaves and small stems to make a leafmeal which you can feed directly or mix with other feeds.

63. How much tree fodder should be fed to livestock? Many fodder trees such as *Gliricidia* and *Sesbania* contain very little or no toxic compounds. You can therefore feed a lot to ruminants, as much as they will eat, particularly during the dry season when there is no other green feed available.

64. Other trees such as *Leucaena* contain toxic compounds that can harm your animals, including ruminants, pigs and chickens. You therefore need to mix them with other feeds to dilute the toxic compounds.

65. For example, you can feed a mixture of *Leucaena* and *Gliricidia* to sheep and goats, making sure that *Leucaena* is not more than 30 to 40 percent of the mixture.

66. You can also mix one part of dry *Leucaena* with one and a half or two parts of crop residues such as maize bran or stovers, but always provide your animals with salt blocks when feeding them *Leucaena*.

67. If you cannot mix the fodder with other feeds because, for example, your animals go out to eat crop residues, grass, hay or straw in the field, offer them an amount of fodder equal to 2 percent of their body weight to supplement the crop residue, grass or hay.

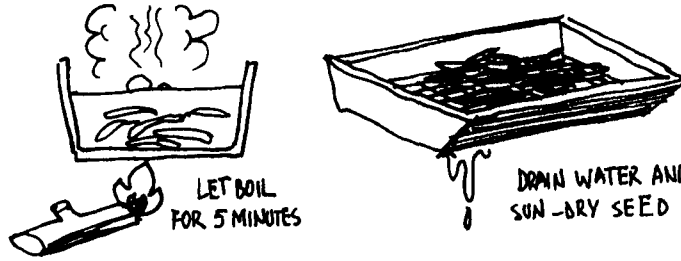
68. For pigs, rabbits and chickens, the amount you can feed is even smaller. In any case do not exceed 10 to 15 percent of the diet for pigs, laying hens and rabbits, and 5 to 10 percent for growing chickens.

69. Other parts of fodder trees that you can feed to livestock are the pods and seeds of trees such as pigeon pea and mesquite.

70. You should not feed such seeds raw or fresh; they should be dried, cracked or ground into flour before you feed them. If they are not cracked or ground before you feed them, the animal may not digest them well and the seeds will just pass out in the faeces with no real benefit to the animal.

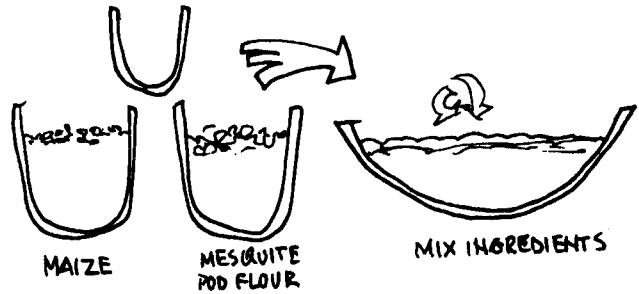
71. Seeds of trees such as pigeon pea and *Prosopis juliflora* also contain some harmful substances that can be destroyed by heating. You need to treat the seeds with heat to destroy these substances before feeding your animals.

72. You can do this by soaking the seeds overnight in water. The next day, drain the water and add fresh water, then bring it to the boil, and let it boil for five minutes. Let the water cool down, drain it and dry the seeds in the sun.



73. You can also just soak the seeds overnight in cold water and dry them in the sun the following day. These methods are long and difficult.

74. So, if possible, buy the pod flour from factories where it has been well processed and mix it with other ingredients to feed your animals.



75. Remember to be cautious, although you can even feed fodder from these trees and shrubs to *ruminants* as the only feed (100 percent), but mix at least two, or more, sorts of fodder. For example, mix one part of *Leucaena* with three parts of *Gliricidia*. Sheep and goats like this mixture. You can also mix one part (40 percent) of the tree fodder with one and a half parts (60 percent) of grasses, hay straw or crop residues (fresh, green or dried).

76. For non-ruminants such as pigs and chickens, dry and grind the fodder, and feed only between 5 to 15 percent of leaves and stems, and no more than 40 percent of pods and seeds in the diet.

However, in any case, remember that the feeding behaviour of your animals fed fodder tree-based diets is a good indicator of what is to be done: to reduce or to change the proportion of fodder from trees in their diets.

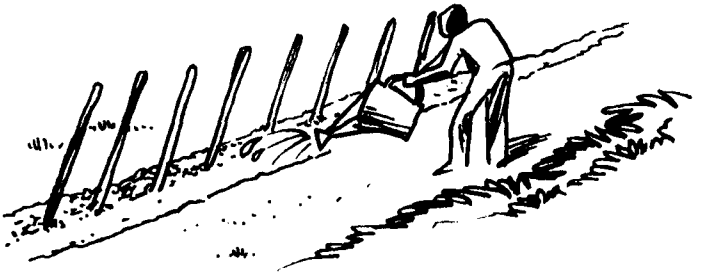
GROWING FODDER TREES AND SHRUBS

77. How can you grow these trees and shrubs to produce the fodder you need to feed your livestock?

78. In many different ways. It will greatly depend on the size of your land; fodder should not compete too much with your crops for valuable land.

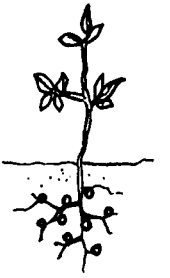
79. On small crop land, you can plant trees such as *Leucaena* or *Gliricidia* to serve as live fences that separate your land from other land, and protect it from animals.

80. Plant the fence from stem cuttings (*Gliricidia*) or seeds (*Leucaena*) placed very close to each other (about 50 cm). Water a lot and take care of the plant as it grows.



81. After six to eight months, start cutting the branches close to the ground, so that more branches can grow to form a strong fence. Keep cutting branches as the tree grows and feed the leaves to your animals.

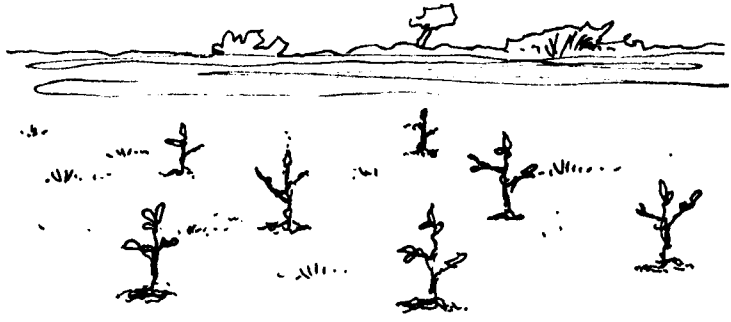
82. You can also plant fodder trees inside your crop land and your crops under the trees. Your crop will get more nitrogen from the tree leaves that fall and from the root of the trees. Do you remember how some trees are able to fix nitrogen from the air?



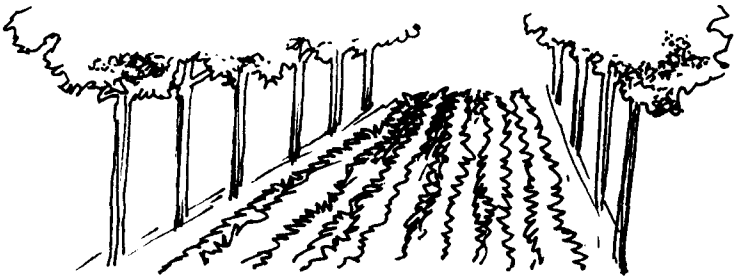
83. Some examples you can try are:

- planting sorghum and maize under or in association with *Faidherbia albida* (*Acacia albida*) or groundnut with *Faidherbia* or cactus such as *Opuntia ficus indica* with mesquite (*Prosopis juliflora*).

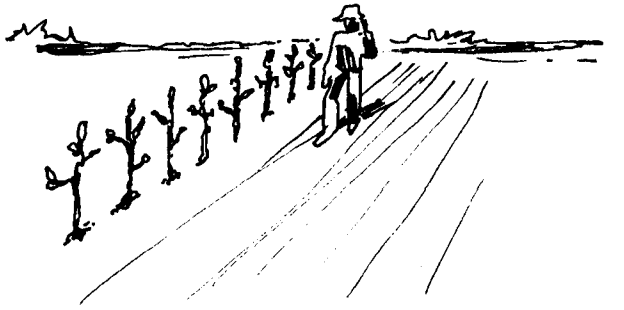
84. You must make sure that the tree does not shade or cover your crop too much. So you should plant the trees 5, 7 or 10 metres apart to give you 60 to 80 plants per hectare, depending on how much land you have, and regularly cut down some branches and feed the fodder to your livestock.



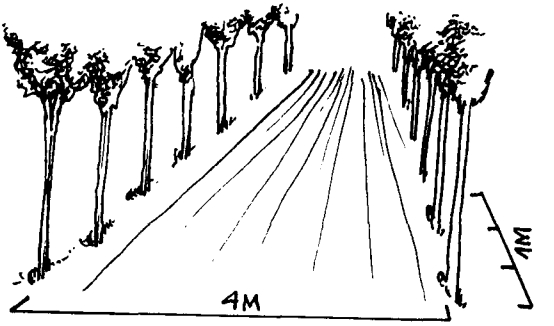
85. Another way is to plant the trees inside your crop land in rows and your crops such as maize, cassava, or cowpeas between the rows of trees. This is known as alley farming and is still being discussed among scientists interested in the subject.



86. One method you can use to establish an alley farm is to plant seedlings of the tree (*Gliricidia, Leucaena, Sesbania*, pigeon pea, etc.) in individual holes arranged in rows.



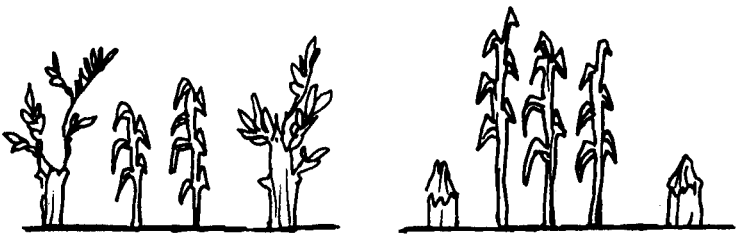
87. Space the holes in a row 1 metre apart, and the rows 4 metres apart.



88. Plant the seedlings at the beginning of the rains and take care of them as you normally take care of your crops; weed and fertilize them and protect them from animals.

89. Leave the trees to grow for one year without cutting. At the beginning of the planting season of that year, cut the trees very close to the ground (30-60 cm), and put the leaves in the space between the rows of trees, where you will plant your crops. These leaves will give nitrogen to your crops and serve as mulch.

90. Your crops will grow, and the tree will grow new branches which you will cut when they become too big, so that they do not shade your crops.

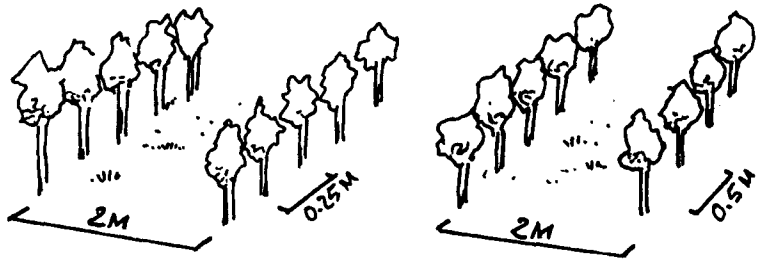


91. You have to decide when to cut the branches as this depends on the type of tree, the type of crop, the season, and the climate, wet or dry. A good guide is every six to eight weeks in humid and ten to 12 weeks in drier areas.

92. As your crop matures, use more and more of the tree leaves to feed your animals, and fewer leaves as mulch for your crop. During the dry season when you have no crops growing and your trees continue to grow, use all of the leaves to feed your animals.

93. You can try other ways of establishing an alley farm. Instead of establishing the trees first for a whole year, you can plant both trees and crops at the same time and take care of them together.

94. You can try smaller row spaces, such as 2 metres between rows, and 0.25 metres between trees in a row, or 2 metres between rows and 0.5 metres between trees.



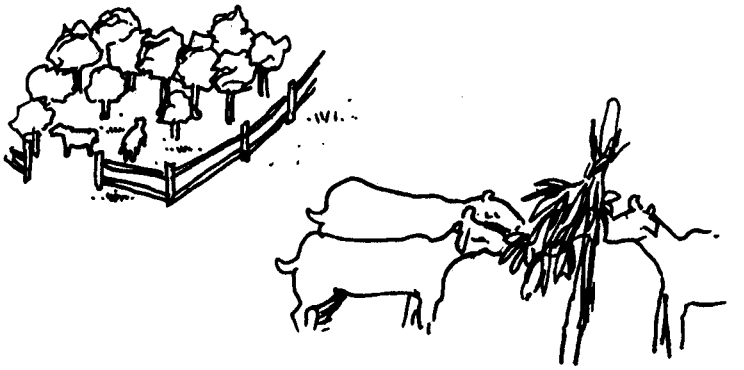
95. Another way to produce some feed for your animals using fodder trees is to plant trees and grasses on a small piece of land.

96. This is called an intensive fodder garden. On a small piece of land measuring 10 x 20 metres, you may get enough fodder to feed five goats or sheep throughout the year.

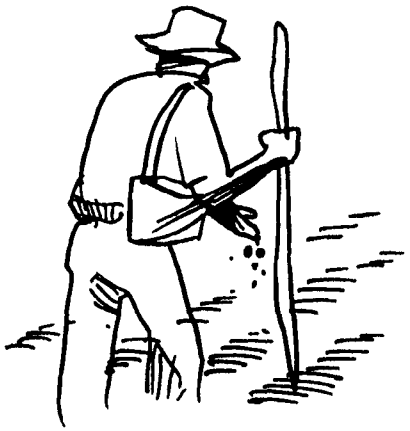
97. You can use *Gliricidia* or *Leucaena* as trees and elephant grass or guinea grass. Try this system where rainfall is high: you will observe that grasses and trees grow rapidly.

98. After establishment, do not cut the grasses for the first time before eight weeks and the trees before 12 months. Then you can cut the grasses once every four to six weeks and the trees once every two to three months, depending on the rainfall. Cut the tree branches at about 1 metre from the ground and the grasses slightly lower at 75 cm.

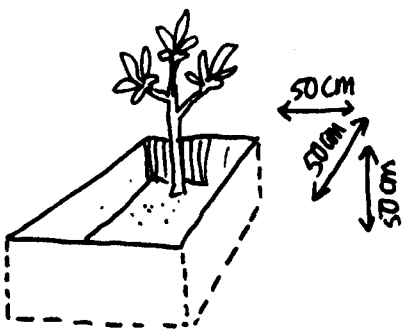
99. You can also use a small portion of your land to grow trees and shrubs, alone or with grasses, to feed your livestock. Your animals can go and feed in a fenced area, but make sure they do not eat too much; in the end, you can also cut the fodder and tie it up for them to eat.



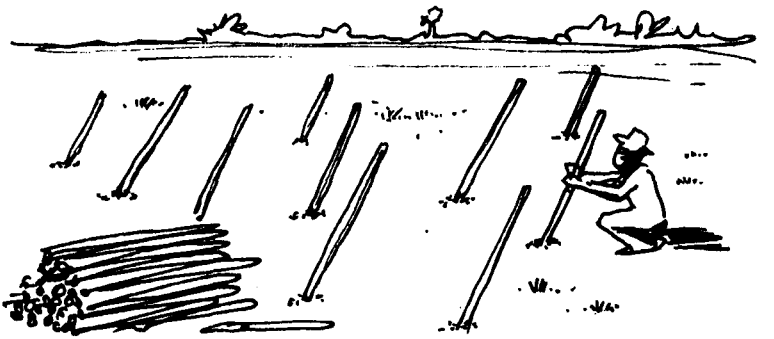
100. You can establish many fodder trees that you need to feed your animals by planting seeds directly;



- or by using seedlings that you first need to raise yourself. We shall see later how to raise seedlings;



- or by using cuttings of stems or stakes (*Gliricidia*). If you plant from stems, you may need a lot of stem cuttings. For example, you may need up to 25 tonnes of stem cuttings to plant an alley farm of *Gliricidia* with the tree rows spaced 4 metres apart as shown.

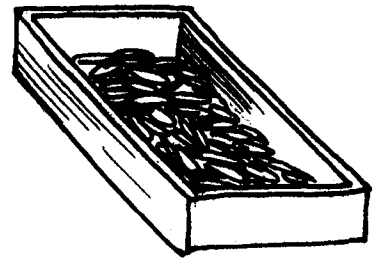


101. If you plant from seeds or seedlings, you will first need to obtain the seeds. How can you get all the seeds you need?

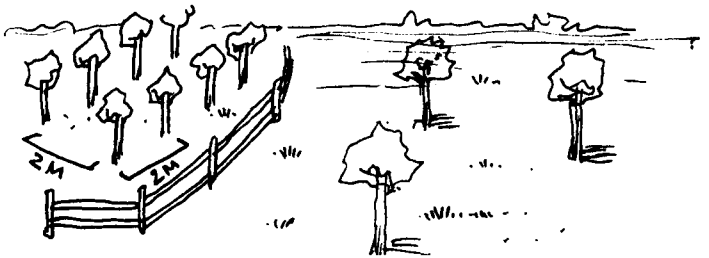
102. For trees such as mesquite, you can collect ripe pods that fall naturally, sun-dry them and remove the seeds as already described. You can get as many as 15-25 seeds in each pod. Using pods weighing about 5 g, if you collect 1 kg pods, you will get about 200-300 pods, that is, about 3 000-7 500 seeds, and sometimes many more.

103. For trees such as *Leucaena*, you can leave the pods to mature on the tree. Harvest when yellow, not when too mature and dark brown, to reduce seed losses through shattering and insect damage.

104. For other trees such as *Gliricidia*, you should not let the pods dry on the tree, or they may shatter and a lot of seeds will be lost. Harvest the pods before they are dry and then dry them in the sun in a container.



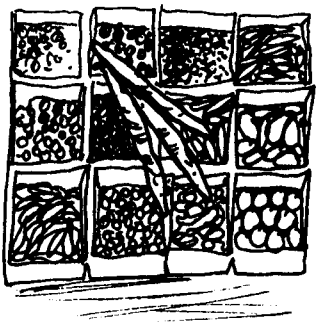
105. You can also produce seeds on a small portion of your land, for your own use, or to sell or give to other farmers. For *Gliricidia* and *Leucaena*, for example, fence a small portion of your land and plant the seeds in rows (2 x 2 metres).



106. Your *Leucaena* plant may flower after nine months and produce mature pods about eight months later. The pods contain 15-25 seeds each. If you collect 1 kg of pods, you will get about 20 000 seeds.

107. *Gliricidia* is a bit slower, and may flower after 18 months, to produce pods three months later. For seed production purposes, do not cut the plants too often, preferably once, and do not harvest seeds in the rainy season.

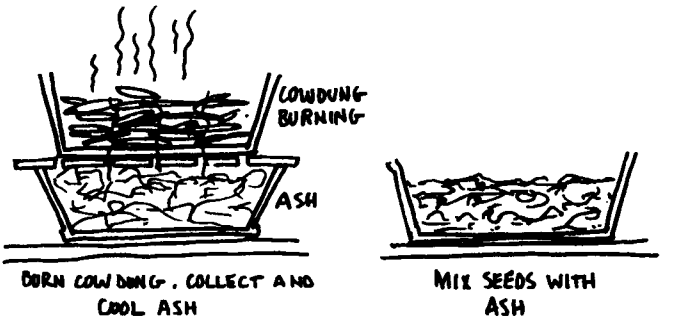
108. If you do not plant seeds immediately after collection, you need to store them properly, so that they are not damaged by insects and moulds. The first thing is to make sure they are properly dried: dry your seeds for three to five days in the sun.



109. Then store them in airtight containers such as glass bottles or plastic bags. First put some material in the container that can absorb water, like dry wood, ash, charcoal, lime, newspaper, dry rice hulls, etc., then fill the rest of the container with the seeds, in order to leave no space for air.

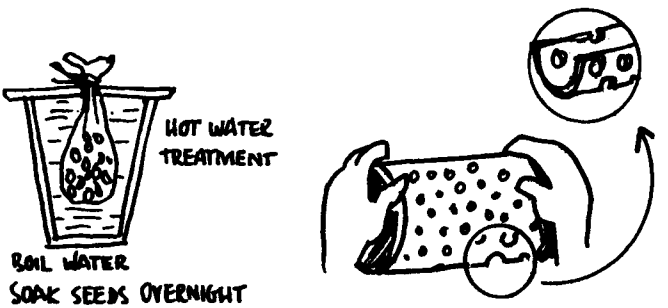
110. Some of these materials such as wood ash not only absorb water, but also protect the seeds from insect attacks. You can also use any kind of vegetable oil.

111. For wood and/or cow dung ash, burn the wood or dry cow dung, let the ash cool down, and mix with seeds, using one part of ash to 200-300 parts of seeds, and store in an airtight container in a cool dry place, or in a refrigerator if you have one.



112. Another way to get seeds is to buy from good sources. You can ask the following organizations: NFTA (Nitrogen Fixing Tree Association), ICRAF (International Centre for Research in Agroforestry), IITA (International Institute of Tropical Agriculture), to direct you to good suppliers near you, or even give you some seeds. See the end of this manual for addresses.

113. Many fodder tree seeds have hard seed coats that slow down and reduce the germination rate. If you want to get high and rapid germination of planted seeds, you must treat them in one of the ways already described and shown again below.

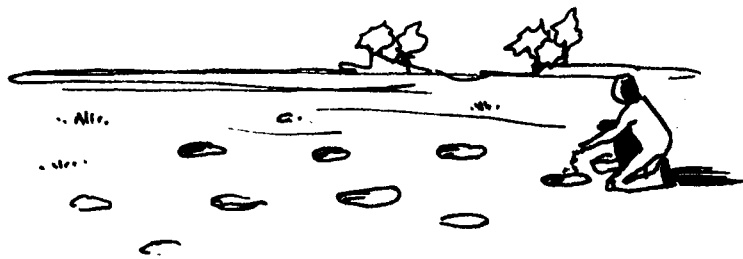


114. Remember that when you plant fodder trees, either by direct seeding or through seedlings, you must take care of them just like your food crops.

115. After clearing the land, sow seeds 2-3 cm deep

in shallow furrows

in individual holes

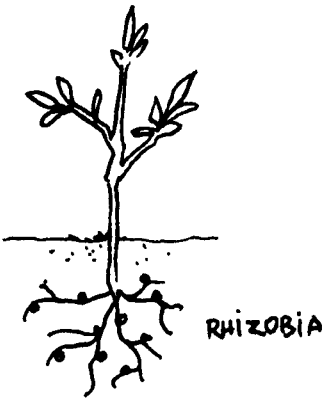


or even under growing food crops such as maize.

116. Many trees such as mesquite and acacia can grow in soils of low fertility, but you still need to fertilize them just as you fertilize your crops for good establishment and growth. You can use animal manure, or find out which type of fertilizer is suitable for your area.

117. Remember also that some trees, called leguminous trees, such as *Prosopis*, *Faidherbia* and *Leucaena* can take nitrogen from the air and turn it into nitrogen that the tree can use to grow, so you may not need to fertilize the tree with nitrogen.

118. It is not the tree itself that makes this nitrogen available, but bacteria living on its roots. These bacteria are called rhizobia.



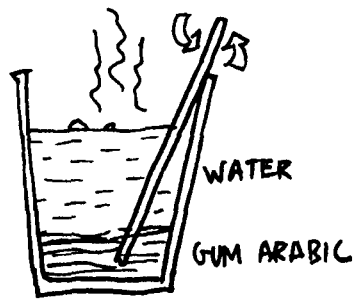
119. Sometimes, these rhizobia may not be present in the soil where you plant your trees, so they do not get this extra nitrogen. This happens when you plant a particular leguminous tree for the first time in your area or on your farm. If your seedlings grow too slowly and the leaves become yellow, it may be because the rhizobia for that tree are not present in your soil.

120. So, when you first plant a particular leguminous tree on your farm, you should "inoculate" the seeds before planting. That means you have to cover the seeds with the rhizobia.

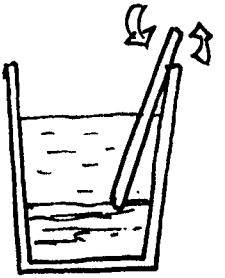
121. How can you inoculate your seeds? Collect some soil from under the same type of trees growing nearby and mix the soil with your seeds before you plant them. You can put some of the soil in the planting holes or furrows.

122. Another way is to buy the special rhizobia you need for your tree from the people who make them, to use on your own farm. (See the end of this manual for addresses.)

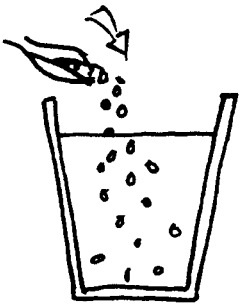
123. Mix the rhizobia with your seeds as follows: prepare a gummy or sticky solution such as gum arabic by mixing one part of gum arabic with two and a half parts of hot water in a bucket, and allow to cool,



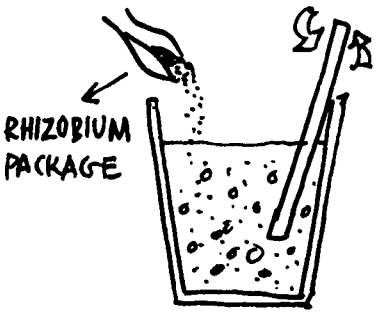
or use a sugar solution and mix one part of sugar and two parts of water.



124. Mix seeds with the gummy solution:
one part of gum arabic plus 25 parts of seeds; or
one part of sugar solution plus 100 parts of seeds;
or one part of vegetable oil plus 50 parts of seeds.

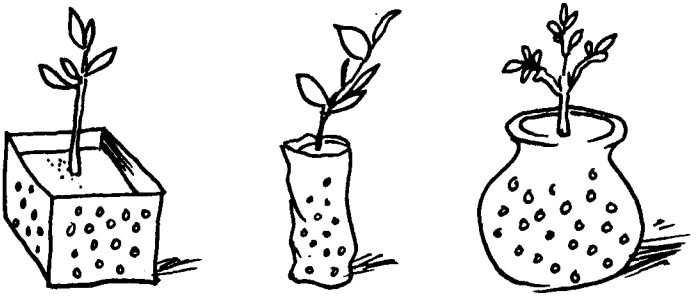


125. Add one part of the rhizobia to 20 parts of the wet seeds and mix well in a bucket or in a plastic bag.

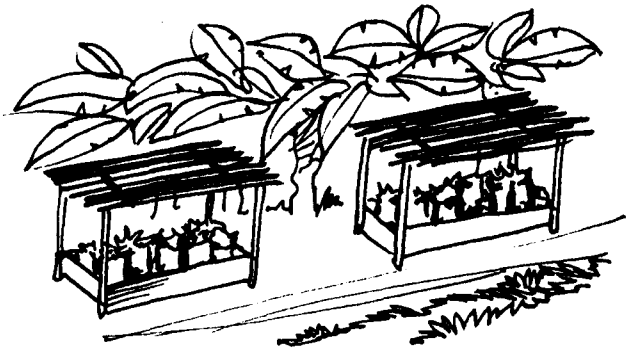


126. Dry the seeds under shade for a while and plant. Sometimes it may be better to raise plants as seedlings and then transfer them to the field some months later when they are strong enough to survive.

127. You can use different kinds of containers to plant the seeds: plastic bags, cardboard boxes or pots.



128. Make holes in the containers so that water does not accumulate at the bottom, keep them under shade, not in direct sunlight, water regularly, and protect them from animals. Move the containers around from time to time, to prevent the roots of the seedlings from going into the soil.



129. Depending on the type of tree, you can plant the seedlings in the field after four to six months, at the beginning of the rainy season.

130. If you take good care of your trees, you will get a lot of fodder for feeding your animals for many years. However, insects and other pests may attack your trees. Treating the soil or trees with insecticides may remove these insects. Planting different types of trees is also a good way to make sure all your trees do not get destroyed by insects. For example, the jumping lice that attack *Leucaena* will not destroy *Gliricidia* or pigeon pea, so these trees are safe when *Leucaena* is attacked.

BOOKS TO READ

131. There is a vast literature on the subject. Some good books/booklets you can read to get more information are:

CIPAV. 1989. *J. Livestock Research for Rural Development.* Cali, Colombia. (diskettes also issued)

FAO. 1977. *Tropical forage legumes.* FAO Plant Production and Protection Series No. 2. Rome.

FAO. 1980. *Useful fodder trees.* Emasar Series. Rome.

FAO. 1981. *Tropical feeds.* FAO Animal Production and Health Series No. 12. Rome. (diskettes also issued)

FAO. 1988. *The current state of knowledge on* Prosopis juliflora. Eds M.A. Habit & J.C. Saavedra. Rome.

FAO. 1988/89. *Nitrogen fixing trees for wastelands.* Bangkok, Rome.

ICRAF/ICRISAT. 1992. Faidherbia albida *in the West African semi-arid tropics.* Ed. R.J. Vandenbelt. Proc. Workshop in Niamey, the Niger, 22-26 April 1991.

IDRC. 1990. *Shrubs and tree fodders for farm animals.* Ed. C. Devendra. Proc. Workshop in Denpasar, Indonesia, 24-29 July 1989.

IDRC. 1990. Leucaena *psyllid: problems and management.* Eds B. Napompeth & K.G. MacDicken. Proc. Int. Workshop in Bogor, Indonesia, 16-21 January 1989.

ILCA. 1980. *Browse in Africa. The current state of knowledge.* Ed. H.N. Le Houerou. Addis Ababa.

MARDI/FAO. 1991. Proc. Int. Livestock-Tree Cropping Workshop in Serdang, Malaysia, 5-9 December 1988. Ed. Z. Ahmad Tajuddin.

MARDI/FAO. 1992. *Legume trees and other fodder trees as protein sources for livestock.* Eds A. Speedy & P.L. Puglièse. Proc. FAO Expert Consultation at MARDI, Kuala Lumpur, Malaysia, 14-18 October 1991.

Nitrogen Fixing Tree Association. 1980. Leucaena *forage production and use.* Hawaii, USA.

Nitrogen Fixing Tree Association. 1987. *Nitrogen fixing trees. A training guide.* Hawaii, USA/Bangkok, Rome, FAO.

Overseas Development Administration. 1993. *Use of trees by livestock.* NRI Series. Booklets 1-4: *Prosopis, Acacia, Gliricidia,* anti-nutritive factors. London, UK.

Singh, R.V. 1982. *Fodder trees of India.* Oxford and IBH Publishing Co. Pvt. Ltd.

Touzeau, J. 1973. *Les arbres fourragers de la zone sahélienne de l'Afrique.* Toulouse. (Thesis)

Von Maydell, H.J. 1983. *Arbres et arbustes du Sahel.* Eschborn, Germany, GTZ.

132. Some useful addresses

- for obtaining information on seeds:

CIAT, Centro internacional de agricultura tropical, Apartado Aéreo 6713, Cali, Colombia.

CIRAD-Forêt, Centre de coopération internationale en recherche agronomique pour le développement, Département Forêt, 45 bis, Avenue de la Belle Gabrielle, 94376 Nogent-sur-Marne Cedex, France.

CSIRO, Australian Tree Seed Centre, Division of Forestry and Forest Products, PO Box 4008 QVT, Canberra 2600, Australia, or Division of Tropical Agronomy, The Cunningham Laboratory, Mill Road, Santa Lucia, Brisbane, Queensland 4067, Australia.

ICRAF, International Centre for Research in Agroforestry, United Nations Avenue, Gigiri, PO Box 30677, Nairobi, Kenya.

IITA, International Institute of Tropical Agriculture, PMB 5320, Ibadan, Nigeria.

ILCA Herbage Seed Unit, International Livestock Centre for Africa. PO Box 5689, Addis Ababa, Ethiopia.

United States Agronomy and Soil Department, University of Hawaii, Honolulu, Hawaii, USA.

- for obtaining information on rhizobia:

CIAT, as above.

CIRAD-Forêt, as above.

CSIRO, as above.

ICRISAT, International Crops Research Institute for the Semi-arid Tropics, Hyderabad, Andhra Pradesh, India.

IITA, as above.

NIFTAL Project, 1000 Holomua Avenue, Paoa, Maui, Hawaii, 96779- 0779, USA.

The Nitragin Company, 3101 W. Custer Avenue, Milwaukee, Wisconsin 53209, USA.

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