Planting nitrogen fixing trees

Leguminous – nitrogen-fixing – trees, are especially useful for soil improvement as a green manure or cover crop. Air is 80% nitrogen gas, N2, but this form of nitrogen is stable, so plants cannot use it. Leguminous plants have specific types of bacteria growing in their root hairs. These bacteria take nitrogen from the air and turn it into a form usable by plants.

This Action Sheet describes a special step called inoculation that is usually needed when planting nitrogen-fixing trees. More general information on tree-planting can be found on Action Sheet 49: Tree Planting. Specific information on Gliricidia sepium – a useful leguminous tree – can be found in Action Sheet 54.

What is inoculation?

Legumes will only fix nitrogen if the right type of bacteria, for example, Rhizobium, is present in the soil. This is especially relevant if the legume is not a local plant. Gliricidia sepium, for example, is originally from South America. Inoculation is the process by which the nitrogen-fixing bacteria are introduced to the tree. Without inoculation, you may find that seedlings grow too slowly and the leaves become yellow. This will be because the right rhizobia bacteria for that tree are not present in the soil. You can inoculate with effective bacterial strains bought from nurseries, or using soil collected from beneath established trees of the same species.

If inoculation is successful, the nitrogen-fixing bacteria will grow in the roothairs of leguminous plants, producing nodules (lumps) on the roots. The bacteria get energy from plants, which feeds nitrogen-fixing process. In return, the plant gets nitrogen, needed for plant growth. The plants grow well, when leaves fall or plants die, nitrogen becomes available in soil for your crops. They are one way for the farmer to let nature do the work!

What can nitrogen-fixing trees do for people?

Because nitrogen-fixing trees meet their own needs, they grow well in infertile soil. They quickly pioneer the land, and can be pruned back frequently for green manure (See Action Sheet 39).
Different trees have different uses – choose large and fast growing trees for fuelwood or poles, windbreak or shade. Choose trees that produce edible shoots and pods for home garden use.

Ways to use NFTs

- Alley-cropping with shade-loving crops (e.g. coffee, citrus)
- Trellis for vine crops like vanilla, pepper and yam,
- Contour hedgerow for soil protection,
- Shelter belts for shade and windbreaks
- Living fences
- Fodder banks
- Green manure/mulch banks
- Cover crops to speed up soil recovery in fallows

A few of Africa's leguminous trees

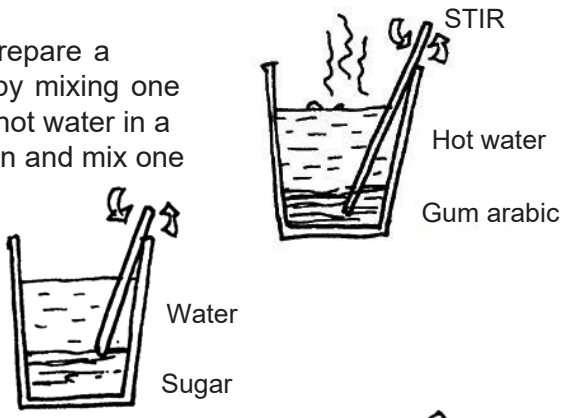
Scientific name	Selected local names	English names
Erythrina spp.	Swahili: mbamba ngoma, mjafari,muhuti, mwamba ngoma	Red hot poker tree Lucky bean tree
Colophospermum mopane	Tswana: mophane	Butterfly tree, Turpentine tree
Tephrosia vogelii	Swahili:kibaazi,kibazi,mibaazi,mtupa, utupa wa kibaazi,utupa wa kingindo, utupa wa mrima	Fish poison tree
Sesbania sesban	Zulu (umQambuqweqwe,umsokosoko)	Sesban
Faidherbia albida	Peul: Tieaki. Senoufo: baazaa. Wolof: cad. Fulfulde: tieaki, tiaski.	White thorn, Winter thorn, White acacia

This is not a comprehensive list. For details about indigenous species, consult experienced farmers, farming association, local extension workers, NGOs involved in agroforestry projects, scientists at regional universities or government scientists.

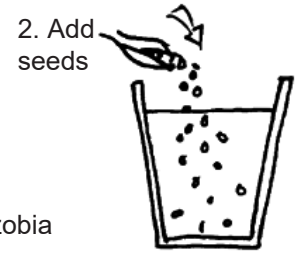
How do you inoculate leguminous tree seeds?

Each tree seed needs special treatment to set off germination. This depends on the species, and usually involves scarification or soaking in hot water. After seed treatment, inoculation takes place at the time of sowing. If bought inoculant is available and inexpensive, you need to stick it on to the seeds with gum, sugar water or vegetable oil.

1. To mix the rhizobia with your seeds first 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.



2. Mix seeds with the gummy or sticky solution:
   - use 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.



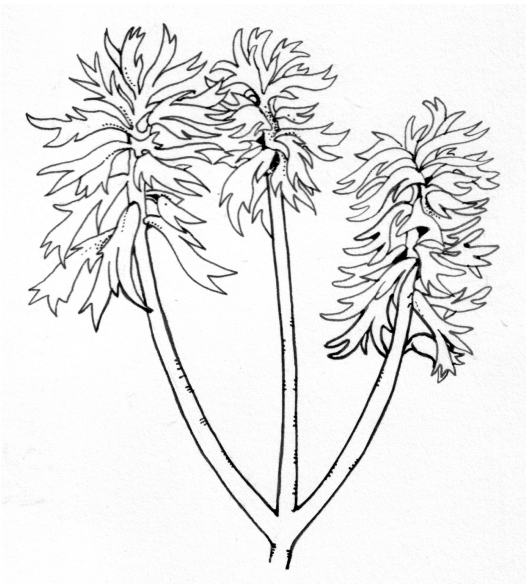
3. Add one part of the rhizobia to 20 parts of the wet seeds and mix well in a bucket or in a plastic bag.

Dry the seeds under shade for a while and do not expose to extreme temperatures or direct sunlight. Then plant them, either in pots, or in the field. 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 (See Action Sheet 49: Tree Planting).

If you cannot buy inoculant, look for vigorously growing trees of the same species you are planting or of a closely related species. Dig up some soil containing well-nodulated roots from under several of these trees and place this fresh material in the pots or holes where the seeds are planted. You know if root nodules are healthy by cutting them open – a healthy nodule will be pink to dark red inside. If a problem arises with parasitic fungi or bacteria, wait to apply the inoculant soil until after seedlings have developed a dry bark and woody stem.

ERYTHRINA ABYSSINICA

Erythrina abyssinica, an indigenous nitrogen-fixing tree, grows all over Africa in the savannah, and has many uses on the farm: fodder (leaves), good flowers for bees, fuelwood, carvings, drums, fishing float (bark), jewellery (from poisonous seed!), medicines, insecticides and poison. It can be planted on contours to control erosion, it gives good shade and shelter, it produces mulch and can be intercropped with coffee and cocoa.



Illustration, Alexi Francis

Planting From seed or by truncheons. Plant truncheons (large cuttings stripped of leaves) at the beginning of the rainy season. If being planted for shade, it can be established rapidly by planting large stakes, 2.5 m long and 8-10 cm in diameter. Stakes this size can produce a canopy of 3-4 m diameter in 6 months. If planting from seed, scarify seeds by rubbing with sandpaper or nicking with a knife. Soak in water for several hours until seed starts to swell or soak in warm water (40°C) for 12 hours. Inoculate seeds with Rhizobium bacteria after pretreatment and immediately before planting.

Seeds germinate best in sterile sand. Sand can be sterilized by washing it in a solution of 5% formalin in water. Seeds should be well separated from one another in the germination box. Alternatively they may be sown directly into black polythene bags, using a mixture of soil, sand and compost in the proportion of 2:1:1. They should be sown just below the soil surface, with the hilum (the scar on a seed coat at the location where it was attached to the plant's stalk during development) facing downwards. Nursery-grown plants are ready for transplanting when 20-30 cm tall. They can be established either by planting directly from plastic bags or by removing from the nursery beds and planting as bare-root stock. In the latter case, all leaves should be removed before planting.

Management Protect young trees from heavy frosts until they are well established. Growth is slow. Pollarding and coppicing are suitable for *E. abyssinica* (See Action Sheet 67). Do not prune trees until they are 1 year old. Frequent pruning will reduce the competitive effects of hedgerows and make more leaves grow per stem, but will increase labour costs and reduce total tree biomass production. With its soft wood, *E. abyssinica* is easier to prune than other species used in alley farming. It may be wise to grow the trees with shade-tolerant crops, rather than pruning it back to favour shade-intolerant crops.

Are there any drawbacks to nitrogen-fixing trees?

If it has to be bought, the inoculation product may be expensive, although it is worth comparing the cost to the return you expect to gain from the tree itself. Other non-legume plants can be better in some situations. They may produce more organic matter and have a better root system. They may also survive better and grow faster and may be able to tolerate extreme weather conditions or poor soils.

Nitrogen-fixing trees can make the soil more acidic or put too much nitrogen in the soil, risking pollution of ground and surface waters. They can become weeds and compete for soil nutrients with crops. It's important to seek local advice before planting a lot of trees on farmland.

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More information
World Agroforestry Centre www.worldagroforestry.org

Nitrogen fixing trees: Multi-purpose Pioneers. Elevitch and Wilkinson, K. 1995 Permaculture International Journal Issue No 56 www.agroforester.com

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