Direct seeding *Faidherbia albida* (syn. *Acacia albida*) in the Sahel.

David Clode, 2011.

Introduction

The *Faidherbia albida* tree is unusual in that it drops its leaves at the beginning of the rains and is dormant during the wet growing season, and so does not compete with plants growing beneath its canopy. The leafless canopy allows more sunlight through, and the fallen leaves provide a nitrogen-rich mulch. Below the canopy a fertile, protected micro-site is created for crops and pasture grasses, and millet crops may be double or more. Therefore, the more trees there are, the more food can be grown, so there is a need for effective establishment techniques for this tree, and other species that enhance crop/pasture growth beneath their canopies. There is also a need for direct seeding techniques that result in new trees growing in specific spots, for example, between existing *Faidherbia* trees. Young trees also need to be established to replace those that die in the future.

In the Sahel region, planting out trees grown in nurseries has proven to be labour intensive and not very successful. Samba, (1992) details direct seeding trials by Cazet, (1987), where direct seeded *Faidherbia* had greater survival rates than pot plants, with greater taproot growth (273cm compared with 149cm). In the Sahel, it appears to be critical that *Faidherbia* trees grow a taproot as deeply as possible, and as quickly as possible, to reach the water table, compared with plants in East and Southern Africa (provenances from these areas growing in the Sahel tend to produce proportionately more top growth and less root growth, but then die). *Faidherbia* seedlings also appear to establish better on sites where the soil is more fertile, such as close to abandoned termite mounds, where soils are less acid and have a higher clay content (Geiger *et al.* 1994).

Some of the techniques suggested in this article could also be applied (or modified as necessary) to other legumes/plants generally in other places. People with local knowledge should feel free to adapt and refine these suggestions as they see fit, since many of these recommendations are speculative, and written by someone who has not been to the Sahel region.

Suggestions for direct seeding *Faidherbia albida*

Collecting seeds

The seeds need to be collected promptly as soon as they are mature, to avoid Bruchid beetle infestation and destruction. Normally in revegetation projects seed would be collected locally to preserve gene pools, but there may be a case for collecting seed from trees further afield, perhaps both North and South, so that some of the trees would be adapted to cope with any possible changes in the local climate. It may also be worthwhile to collect seeds from trees that have a wider than average canopy, to provide a larger area for crops to grow, and fast-growing trees. While it may be tempting to grow only *Faidherbia* trees, it may be wise to

grow, for example, other *Acacia* spp., *Prosopis africana, Parkia* spp. etc., to avoid a monoculture, which might succumb to a particular pest or disease.

Storing seeds

Seeds need to be stored in a cool, dry place and need to be protected from rodents and insects. Chopped up *Neem, Vernonia galamensis* or *Pongamia pinnata* leaves might protect against insects in storage.

Treating seeds

Many leguminous trees have a hard seed coat, and *Faidherbia* is no exception. Work carried out by the Eden Foundation (Beckman, 1990) found that *Faidherbia* seed nicked with nail clippers gave the best germination, and nicked close to the micropyle, not at the furthest end. The next best treatment was using a blade, which was better than boiling water treatment. While it is labour intensive, nicking individual seeds with nail clippers appears to be the best way to scarify the seeds. In my experience this is also true of *Acacia melanoxylon, A. mearnsii* and tree lucerne.

Before sowing, it is best to let the seeds absorb water, and just start to germinate before sowing them (perhaps 10% just germinating, with the radicle just emerging). This means that the seeds spend less time exposed to the elements and to potential seed predation, both of which can destroy the majority of seeds in the field.

Seeds could be stored in a bucket or other container, in water for 12 - 24 hours initially, then the water poured off (cover the bucket with flyscreen or similar) and the seeds kept moist but not wet, and re-submerged daily for about 10 minutes, until signs of germination, when they should be sown. Discard any seeds that float. Alternatively, seeds can be spread out on a few sheets of water absorbent paper, and kept moist. The radicle should emerge in 48 – 72 hours (Barnes and Fagg, 2003).

Sowing seeds

Direct seeding should be undertaken early in the wet season, to allow as much time as possible for the plants to establish before the dry season, but only after good, penetrating rains. A few weeks after the seedlings appear, thin them out leaving one robust seedling. If at all possible, seedlings should watered at about five day intervals, two or three times.

Furrows and basins

In Australia, a reference from the late 1800's suggests making a furrow, and sowing pre-treated acacia seeds at a depth of no more than 5mm in May (early in the wet season in Southern Australia and the recommendation was probably for *Acacia decurrens* and *A. pycnantha*, and perhaps *A. mearnsii*) (Venning 1988). Also, there is a general rule in sowing vegetable seeds, including legume vegetables, to sow seeds at a depth of one (to two) times the diameter of the seed. *Faidherbia* seeds are somewhat larger than the acacias mentioned,

(6-12mm x 4-8mm, Barnes and Fagg, 9-11mm x 6-8mm, Faradah Hanum and van der Maesen, 1997) and so a sowing depth or soil coverage of around 10mm is indicated.

The Eden Foundation found that sowing seeds of *Faidherbia* at a depth of 15mm was better than 10mm. However they point out that the greater depth reduced seed predation, and that the topsoil was a coarse sand (which would have a low water holding capacity). It is also a general rule when sowing vegetable seeds that better germination and establishment is achieved when the soil over and around the seeds is pressed down gently by hand or using a gardening tool (this presumably improves seed/soil contact, and increases the water holding capacity of the soil around the seed, providing improved imbibiton and germination). Thus, if seed predation can be reduced by using decoy seeds and repellents, and the seed is gently firmed down, then a compromise sowing depth, or soil coverage, of 10mm should work reasonably well.

Ahmed (1986) was successful in establishing *Prosopis chilensis*, by direct seeding into "saucer-pits" and into furrows with ridges (Sudan). Therefore, in areas that have a slope, even if it is slight, a "V" shaped furrow of approximately one to one and half meters long, and about 10cm deep, could be made using a hand-held hoe or other suitable tool, in one, slightly curving, movement. The furrow would be made horizontally on the contour, and could be slightly curved, to catch water that would otherwise run off. The furrow should be formed so that the ridge of raised soil is on the downhill side. Demi-lunes (half-moons) are another technique for sloping ground, see http://pdf.wri.org/worldresources_2008_roots_of_resilience_chapter3.pdf, page 149. These are a proven technique, but require a little more work to construct. A half-moon shaped basin is dug, with the ridge on the downhill side. They are flat and open on the uphill side, so that water flows into them, ponds, and infiltrates. If multiple half-moons or furrows are made close to each other, they would be staggered to maximise the catchment area uphill from them. The furrow/half-moon would then be watered with .5 to10 litres of water (the more the better), which has had 20-50% human urine added, plus some wood ash, powdered burnt bone, and anything else which might improve soil fertility and which is free or cheaply available. Around five to ten pre-nicked and pre-germinated seeds would then be sown in the central third of the furrow, about 10mm deep, or covered with about 10mm of soil, and gently firmed down by hand or with a tool.

On flat ground, round or oval basins (which could also be called saucer-pits, craters, volcanoes) of about .75m to 1.5m diameter could be scooped out, again to a depth of approx 10cm or more, and sown as above, with seeds in the central third of the basin. Water from rainfall, and water which is added by hand, should concentrate at the centre, and infiltrate deeply, forming a column of stored moisture, for the taproot of the *Faidherbia* tree to follow (at least in theory).

Furrows or basins should be well mulched, about one metre or more metres diameter, with leaves and/or dry grass (with no weed seeds) to reduce the need for later weeding, minimise evaporation losses and keep the soil cooler. If there is browsing livestock or wildlife in the area, then seedlings will need to be protected with thorny branches for the first few years.

Thorny branches could be pushed into the ground, forming a surrounding cylinder, or formed into a tepee shape, or simply piled around in a circle, and tied together with string if necessary (see plate 101, Mollison 1988). This should provide some protection for the growing seedlings from livestock and wildlife browsing, but also from abrasion due to sand blasting, and from strong sunlight and heat. Thorny acacia branches should be available. From personal experience, this has worked using thorny branches of African boxthorn, *Lycium ferocissimum* to protect young trees from rabbits in S. E. Australia. Some extra dry grass laid down on and just above the ground on the windward side should provide extra protection from sand blasting. Seedlings may also need to be protected from fires.

When digging furrows or basins, existing *Faidherbia* roots may be encountered. These should be cut and should produce "new" trees from sucker growth. It may also be possible to get sucker growth by using a draft animal and a ripping/cutting implement drawn between existing *Faidherbia* trees. It should also be possible to make an animal-drawn implement which scoops out basins of some description, which would also be useful for establishing windbreaks of *Acacia torulosa* (multi-trunked, bushy form), for example.

-Decoy seeds

Decoy seeds such as whole *Faidherbia* pods, spoiled millet or Australian acacia seeds, melons cut in half eg. *Cucumis melo* spp. *agrestis*, or similar, could be broadcast onto the soil surface by hand, all around the furrow or basin, a metre or so away. This could be done for a few nights before sowing (to train seed predators such as rodents and ants to look for seeds in the same decoy area, and perhaps to fill them up so that they may be less interested in digging up and harvesting the *Faidherbia* seeds) and for possibly a week after sowing.

-Repellents

Chopped up Neem or *Vernonia* leaves may help to repel seed predators. Vinegar, a mix of copper sulphate and lime, or borax may help to repel or kill ants. Human urine which is a few days old may repel rodents and browsing livestock. A rotten egg and water mixture should repel browsing livestock, but is a very unpleasant substance for people as well.

Seedballs

Seedballs are a technique developed by Masonobu Fukuoka, and used by guerrilla gardeners in urban environments. The balls are usually golf ball size or less, and made of five parts clay and three parts compost, plus one part of a mix of seeds.

A variation of this technique is suggested here. It is suggested that not less than 30% and up to 90% clay (possibly crushed material from abandoned termite mounds, or if clay is not available, silt or mud made up of fine particles) should be thoroughly mixed with not less than 10% and up to 70% good quality topsoil, obtained from beneath mature *Faidherbia* trees, including nodulated roots, which have been chopped up and crushed. Other additives which increase the fertility of the mix should be included if possible, at around 5% of the mix, per additive. Additives could be wood ash, (Ca, K, raises the pH and thus nutrient availability), or lime or dolomite, rock phosphate, burnt bone (highly available P, Ca) and

anything else which is available and which is free or cheap. The water could have up to 50% human urine (NPK and trace elements) added to it. Livestock manure is not recommended, as the smell is more likely to attract seed predators, although it could be used if it is very well composted. Vermicompost would be useful if it were available.

The mixture could be made in a plastic bucket, to a wet, sloppy consistency. A heaped handful is then scooped up with one hand, while with the other hand a hole is made in the centre with the thumb. Five to ten pre-germinated seeds are then placed carefully in the centre, and the ball gently squeezed closed. The seedball is then placed in or near the centre of the basin or furrow. This technique surrounds the seeds with a large volume of wet material, providing some protection from dessication, seed predation and temperature extremes, as well as providing appropriate beneficial bacteria/mycorrhizal fungi, and extra nutrients.

These seedballs could simply be used without furrows or basins, thorny branches, decoy seeds, repellents etc. but this is likely to have a much lower success rate. In circumstances where the exact placement of trees is not critical, *Faidherbia* seeds could be fed to livestock to disperse them, but again with a relatively low success rate.

The "nurse tree" technique

Since it is critical that *Faidherbia* trees establish a deep root system quickly, and that they establish better in more fertile sites, it may be advantageous to grow a fast-growing, deep-rooted tree for two to three wet seasons beforehand, so that it grows deep roots and "prepares the way" for the *Faidherbia*.

The nurse tree would be sown off-centre in the basin or furrow. After a few wet seasons, the nurse tree would be ring-barked (strictly speaking, "girdled", where a cut is made all around the base of the trunk, through the phloem and importantly into the xylem) with a knife or machete to kill the tree, and the *Faidherbia* sown close to it. The dead nurse tree should be left standing, providing some protection from sun and wind, and could be used as part of the thorny branch protection as well. Theoretically, the *Faidherbia* should be able to grow its taproot deeper and faster by following the path created by the nurse tree roots. The nurse tree would also help prepare the site by dropping leaves to provide mulch. The dead tree may attract birds which deposit dung and increase fertility, and owls at night may perch in the dead tree and catch seed eating rodents. Some suitable trees might include nitrogen-fixing *Acacia torulosa* (multi-trunked, bushy form), probably the best option, or *A. holosericea, A. elecantha*, see www.worldwidewattle.com, and Cunningham and Abasse (2005). These Australian acacias grow much faster than indigenous acacias in the Sahel. They produce edible seeds, and much more leaf litter/organic matter, which improves the soil, increasing water holding capacity for example, and fuel wood. On wetter sites *Sesbania sesban* may be good. The disadvantage is the loss of two to three years, however, the *Faidherbia* might grow faster and catch up, and establish better with this technique.

Another possibility would be to establish a semi-circle windbreak as well, using *Acacia torulosa* for example, about 5-10 metres away on the windward side. This could grow for 5

years or more, providing wind protection for three years or more, and provide leaf mulch for the *Faidherbia* tree. It would also increase fertility for crops later.

The "fertile island", or "mixed, improved fallow" technique

The long term aim is to provide a more fertile area in which to grow crops, and so a mixed, improved fallow (green manure) forming a circular "island", perhaps 8-25 metres in diameter, could be a good way to start. The fertile island could be centred around an abandoned termite mound. Species used in East and Southern Africa are unlikely to perform in the semi-arid and infertile sandy soils of the Sahel, and so different, more suitable species will be needed. Results are also likely to be slower and not as good.

The fallow plants would be seeded into furrows, half-moons or basins. Creating a fertile island by growing soil-improving plants for at least one, but preferably two to three wet seasons should improve the survival and speed of establishment of a *Faidherbia* tree seeded in the middle, after the one to three wet seasons. Plants could be killed by ring-barking or cutting the stems below ground for at least a six metre diameter circle around the *Faidherbia*, before it is sown, so that the *Faidherbia* has no competition. In the second and third wet seasons, and onwards, food plants such as millet, cow peas and okra should provide a reasonable crop, around the perimeter. Plants which also provide medicine, food or some other additional use, are likely to be favoured by local farmers. Some plants which may be suitable, preferably in a mixture:

Acacia torulosa (bushy form), *A. holosericea*. *A. elecantha*. These relatively fast-growing acacias should form the 'backbone' of the fallow, and provide edible seeds, and can be lopped for mulch and fuel wood. The acacias could be considered a substitute for *Sesbania sesban* (which would be a first choice in wetter regions),

preferably indigenous *Crotalaria* spp. (nitrogen-fixing), *Cajanus cajan* (nitrogen-fixing and edible beans), possibly *Sesbania sericea* in wetter sites,

Asteraceae spp., which may increase fertility through more efficient nutrient uptake as a result of mycorrhizal association, and may suppress nematodes, eg. *Vernonia galamensis* (see Fakara plants, internet resources at the end of this article) and *Vernonia* spp., possibly *Tithonia rotundifolia* in wetter places, possibly *Cosmos sulphureus* (but it is likely to self-seed and become a weed), or other indigenous Asteraceae spp.,

nitrogen-fixing, preferably indigenous ground covers, possibly *Vigna marina, V. unguiculata* (cow pea), *Vigna* spp., *Canavalia cathartica* (syn. *C. ensiformis*), *Canavalia maritima*, *Canavalia* spp., *Macroptilium atropurpureum* (may not be wet enough),

other groundcovers/climbers such as *Lagenaria siceraria* (gourd), indigenous Cucurbits/melons, or possibly from Southern Africa, *Ipomoea pes-caprae*, *Portulaca oleraceae* (surface sown, needs light to germinate, fodder),

Panicum laetum (Fonio, edible grain), okra (edible flower buds).

Some possibilities gleaned from www.echonet.org/ :

Vigna aconitifolia – Moth bean – "India, most drought-tolerant legume grown in the country. Requires 500mm or less; can be successfully intercropped with sorghum, millet, cotton."

Phaseolus acutifolius – Tepary bean "very drought tolerant, requires low humidity."

Centrosema pascuorum 'Cavalcade' - "700-900mm", less than *Macroptilium atropurpureum*, "760-1780mm".

The Zai hole technique

Make a circular island of multiple zai holes (with cow or goat manure incorporated into the holes), around .75-1metre diameter each, interspersed with an equal number of basins with A. torulosa (or similar). Spaces between the Zai holes/basins could be .75-1metre, or more in drier areas. Alternatively, the acacias could also be grown in zai holes, and if there is not enough animal manure available, human manure could be used at the bottom of the holes. Grow crops and use leaves/loppings from the acacias as mulch, for 1-5 wet seasons (similar to *Gliricidia* intercropped with maize). Every second branch of the acacias could be lopped, leaving some branches to provide edible seeds, and some shading. When sufficient fertility is built up, kill the plants in the centre (about 6 metre diameter), and sow *Faidherbia*.

The "fertile doughnut" or "fertile atoll" technique.

As for the mixed improved fallow or zai hole technique, but sow the *Faidherbia* at the same time, in a bare circle, 6-8m diameter., surrounded by a perimeter of crops/acacias/fallow species. This will get the *Faidherbia* started straight away, but without the preparation of more fertile soil for the *Faidherbia*, that would be created by the above techniques. Nevertheless, the "doughnut" would increase fertility for crops later, and perhaps provide a windbreak so that the *Faidherbia* may grow faster in the early years.

The "stockpen" technique

A stockpen could be made using thorny branches, perhaps 6 - 25 metres in diameter. Livestock kept overnight in the pen for a few nights to a few weeks, would deposit dung and urine and so add organic matter and nutrients. The stock could be fed with soil improvers such as clay and wood ash, burnt bone, (and perhaps seeds of fallow species) beforehand. *Faidherbia* could be sown in the centre soon after the application of manure and urine, and crops/fallow species grown around the perimeter (within) the stockpen. The stock would then be kept out, so that the *Faidherbia* can grow safely. Alternatively, crops/fallow species could be grown for a few seasons, with livestock allowed in at an advantageous time after the harvest, to add more dung and urine, and then sow the *Faidherbia.* Crops/fallow species could then continue to be grown around the perimeter, but a few metres away from the *Faidherbia.*

The "arborloo" technique

The arborloo is a pit toilet, which, when near-full is covered with soil, and a tree planted on top. See http://www.aquamortripod.com/arborloo2.htm, and www.ecosanres.org/factsheets.htm, see factsheet 13. This could be useful near settlements, with the human manure providing nutrients, higher pH and higher water holding capacity. Since Faidherbia trees need to grow deep roots quickly, aborloos might be dug which are deeper and narrower than normal.

Conclusion

Some of these techniques may seem labour intensive, but it is probable that the more effort that is put in, the better the results. Given the long-term benefits of this tree, the extra effort should be worth it. In time, increasing soil fertility and microclimate amelioration by these techniques could not only increase productivity, but also enable farmers in the Sahel to grow a wider range of crops, including sorghum and perhaps maize in the future.

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Some internet resources

http://www.bodley.ox.ac.uk/users/millsr/isbes/ODLF/TFP41.pdf Barnes and Fagg, *Faidherbia albida* monograph.

www.worldagroforestry.org/evergreen_agriculture

www.worlwidewattle.com/

www.jircas.affrc.go.jp/.../FakaraPlants/Fakara_Plants_home.html

Http://www.westafricanplants.senckenberg.de/

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www.florabank.org

www.drylandfarming.org

www.fas.org/ota/reports/8321.pdf

http://www.cglrc.cgiar.org/icraf/improvedfallow.pdf.

http://ecoport.org/storedReference/559660.pdf