Edible, multi-purpose Australian Acacias for Africa's Drylands: Technote.

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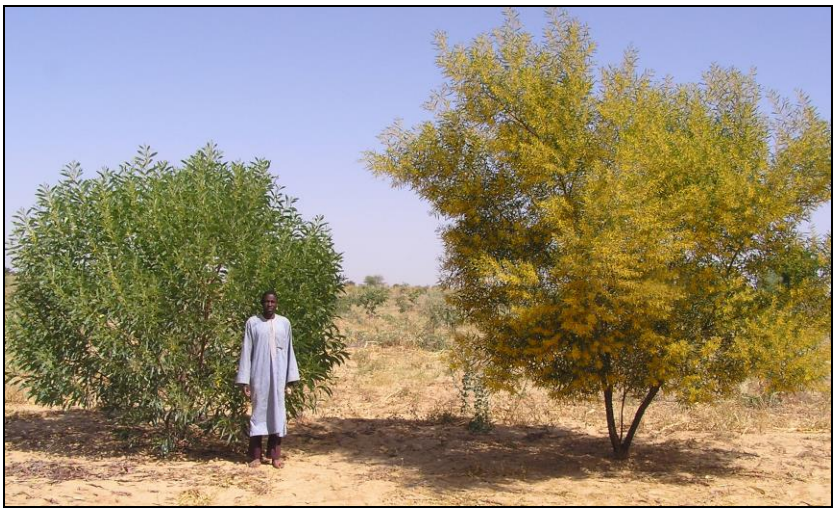
Introduction.

Australian Acacias were first introduced into semi-arid regions of Africa in the 1970's as windbreaks and fuel wood. There has been an ongoing program in the Maradi region of Niger since the 1980's to development and use these *Acacias* as an alternative source of human food. Two main species, *Acacia colei and A. torulosa* have been developed and more recently the multi-purpose value of these trees is being recognised. These trees are well adapted to harsh semi-arid conditions with highly variable annual rainfall of 350-500 mm and grow well in a range of soil types, especially poor sandy soils. They are pioneer species which establish well in tree nurseries and have rapid growth (3-4 m) in two years. Importantly they produce good quantities of safe, nutritious seed (~2 kg/tree/yr.) which is high in protein (21-23%), carbohydrate (50%), fat (7%) and fibre. When the seeds are ground into flour they can be mixed with cereal grains and incorporated into a range of local foods. Flowering and seed production is enhanced through pruning/coppicing which also produces large amounts of sustainable fuel wood and improves tree longevity.
These trees can also play a vital role in the restoration of degraded land, where they rapidly colonise barren land, fix nitrogen and produce biomass and mulch for soil amelioration. Agroforestry farming systems have also been developed

Acacia colei and A. torulosa.



A.colei (3 yrs.) *A.torulosa* (3 yrs.) Niger.

There are two main varieties of *A. colei*:

1. Var. colei which has straight or curved pods that ripen progressively up the stem over an extended period (up to 2 months). The seeds do not cling to the pod and "shatter" easily, spilling to the ground. Harvesting by spreading a sheet on the ground and beating the branches with a stick improves the seed harvest. This variety has not been promoted because the second variety- ileocarpa has superior seed retaining and harvest qualities.

2. Var. ileocarpa is a coiled podded type which ripens over a shorter period (3-4 weeks). The seed remains inside the pod more securely and harvesting can be done by hand. The pods can be left on the trees for some time without fear of "shattering". The seeds are separated from the pods through light pounding in a mortar and winnowing. It should be noted that dust given off during pounding can irritates eyes and nose, causing watering and sneezing. If possible, protective glasses are recommended during harvesting.

A.colei var. ileocarpa seed pods

A.colei var. colei seed pods

A.colei has proven to be the most valuable Australian Acacia species in Niger.
It's ease of establishment in the tree nursery, rapid growth in the field, good seed production from 15 months, high biomass and rapid recovery after pruning yield good quantities of fuel wood. Some farmers also prune the side branches for pole production after 4 years. There are however limitations such as short life span (5-10 years), die back beginning in the third year, susceptibility to wind damage, seedless years and competition with annual crops. Correct tree spacing, pruning, weeding and ensuring crops are planted 1 m from trees help to overcome these limitations (see Guidelines below).

A.colei seed pods at harvest

A.colei seed.

Acacia species and provenance trials have also led to the development of *A. torulosa*, which compliments and overcomes some of the limitations of *A. colei*.

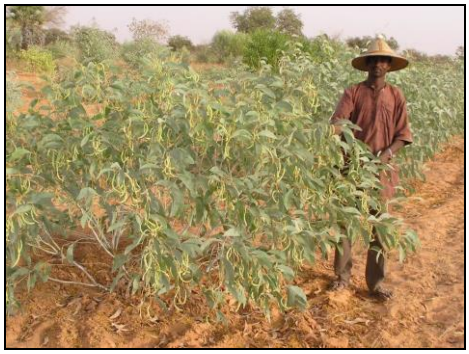
A.torulosa was also selected for its ease of nursery establishment, field growth and seed set at 15 months. It also produces larger seeds in pods which are more easily harvested and thrashed. This species is deeper rooted, less competitive with annual crops, longer lived (>15 years) and recovers rapidly after pruning which also produces sustainable fuel wood.

A.torulosa seed pods- ready for harvest

A. torulosa- ease of seed pod thrashing

A.tumida, A. elachantha ….

Species and provenance trials are underway with other promising acacias such as *A. tumida* and *A. elachantha* (Close relative of *A. colei*) *A. tumida* subspecies (Kulparn & Tumida) have growth well as Maradi, but good, consistent seed production has been elusive. New provenances of *A. tumida* subspecies. Pilbarensis are now under investigation



A.tumida var. Kulparn

A.tumida var. Tumida

A.tumida seed, seedpods

A.elachantha (2 years)

A.elachantha seed pods at harvest

Propagation.

The most successful method of propagating *A. colei* and *A. torulosa* has been through raising seedlings in the nursery and planting out after 8-12 weeks. Direct sowing has not been consistently successful to warrant its widespread promotion, especially with the more erratic rainfall and climate change currently being experienced in the Sahel. Good tree nursery set up, sowing, care, watering and protection is critical for success.

Tree bags/pots should be filled and ready for planting in early to mid-April (approx. two months before the expected start of the rainy season). The general potting mix recommendation is to add 75-80% sand with 20-25% dried and ground cow manure. An insecticide to deter termite attack is also added to the potting mix before tree bags/pots are filled.

Tree nurseries should be established in villages by trained or experienced nurserymen and placed near wells if possible to reduce high labour costs/time transporting water. Good quality, sturdy fencing (wire mesh, thorns, millet stalks etc.) is also needed to ensure animals do not destroy seedlings.

Village tree nursery.

A. colei seedlings (foreground) 10 weeks.

Before tree bags/pots are sown **Seed treatment** of both species is critical for good germination. Seeds are placed in boiling water for one minute then planted directly into tree bags/pots. At least 3-4 seeds are sown into each tree bag/pot to ensure adequate seedlings emerge in case of variable germination.

Relative seed sizes: *A.torulosa*, *A.tumida*, *A.colei*

Table. Acacia seed weights and quantities for sowing bags/pots

Acacia species	1000 seed weight (g)	Weight seed per 1000 bags/pots (g)
A. colei	10-11	40-45
A. torulosa	36-38	144-152
A. tumida	80-82	320-328
A. elachantha	9-10	36-40

Approx. 4 seeds sown per bag/pot.

Acacias are legumes which have a symbiotic partnership with Brady *Rhizobium* which form root nodules and fix nitrogen. Well nodulated Acacia seedlings grow rapidly and show greater vigour especially in the first year. Inoculants with Brady Rhizobium inoculation have not been developed for the semi-arid acacias, but *A. colei* readily nodulates with a range of indigenous Rhizobium from local/indigenous Acacia trees such as *Acacia nilotica.* *A. torulosa* also nodulates from local Brady *Rhizobium* in the tree nursery. *A. tumida* and some other acacia species seem to have more particular nodulation requirements. Nodulation and nursery growth of *A. tumida* has been improved by adding soil gathered from under large *A. tumida* trees to the potting mix.

Special problems related to Sahelian conditions often arise and can be devastating to nursery stock. Remote village nurseries, far from any greenery during the final dry season months of April and May, seem particularly vulnerable.

Problems include: Lizards, grasshoppers, chickens and certain bird species are particularly destructive in the nursery when there is little other food available and the nursery has the only greenery about. Placing the nursery at least 30 meters from houses and large trees usually reduces the incidence of attack. In some years the only way to stop bird damage is by placing chicken wire over the pots until the seedlings are large enough to no longer be attractive to birds. Some villages place boys with sling shots in the nursery to reduce the lizard population. If the nursery is near the village well the fence must be sturdy and reinforced with thorns to prevent damage from livestock. Frogs are attracted by the moisture in the tree pots where they rest and burrow, digging out seeds

and seedlings. Large acacia thorns placed pointy- end-up in the pots are a powerful deterrent. Frogs can be trapped by using buckets. The buckets are placed in a hole with the rim at ground level. Several litres of water in the bucket attract the frogs but once they are in, they cannot jump or climb out. In some years and on some sites termites eat the plastic tubes! If appropriate insecticides such as “Rambo” (Pyrethrum) salt or ashes can be worked into the soil where the pots will be placed.

Field preparations and planting out.

Locations for planting acacias should be identified before the rainy season and include farm borders, degraded areas-demi lunes, banquettes etc., in compounds, beside houses or in Agroforestry farming systems. Tree holes (25 x 25 cm) can be dug after the first rains and when the soil is easier it dig. Whilst ground rock phosphate and a small amount of NPK fertilizer can help early growth, one shovel of compost mixed with soil to back fill the tree hole is a good method when compost is available.

Tree hole & 1 shovel of compost.

Note seedling size. 1 Spoon of Rock phosphate

The timing of planting is also important. If seedlings are well developed in the tree nursery and tree holes prepared, seed lings should be planted as early as possible after 2-3 rains when good moisture (>25 cm) is available.

When planting out, wait until a good rain >20 mm, ensure all the tree bags have been well watered in the nursery, then transport them to the field for planting into moist soil as soon after the rain has finished. These acacias should need no additional watering and establish strongly.

Spacing.

Farmers have been quick to note that competition of *A. colei* with nearby crops can be severe, especially in low rainfall years. Acacias should be planted at 5 - 10 m intervals along farm borders or in pre-arranged agroforestry farming systems. Other plantings include roadsides, along water flow lines or streams and degraded waste land, land not suitable to agriculture or land being left fallow for an extended period.

Acacias have been used as windbreaks on cropland but need to be wide spaced (e.g. 25 – 50m) between rows so as to minimize competition with crops and 8 -10 m within rows.). Both *A. colei* and *A. torulosa* help as windbreak species but because they are widely spaced and ideally pruned to 1-1.2 m above ground every second year, their effectiveness is limited. However in a farming system (see FMAFS below) with indigenous trees (Farmer Managed Natural Regeneration- FMNR) there is an important wind break effect

A.colei & *A.torulosa* (3 yrs.) as windbreaks on farm border

A.torulosa. Note competition effect with annual crop

Pruning can reduce competition

Cultivation.

Cultivation is critical for good seed yields and the health of the trees. Growth, vigour and seed set are adversely affected by weeds and proximity to other woody species. During the rainy season, two or three cultivations should be adequate for weed control. During the dry season, cultivations at least once a month during flowering and seed set would reduce soil surface evaporation.

A.colei. Cultivation helps reduce moisture loss in the dry season.

Fertilizer.

There appears to be limited benefit from the application of rock phosphate or mineral fertilizers (NPK). Good early growth responses are generally seen if compost is incorporated in the planting hole before transplanting. As the acacia trees mature (2-3 years), significant amounts of leaf mulch will accumulate around trees. Termites incorporate this material to build up organic matter.

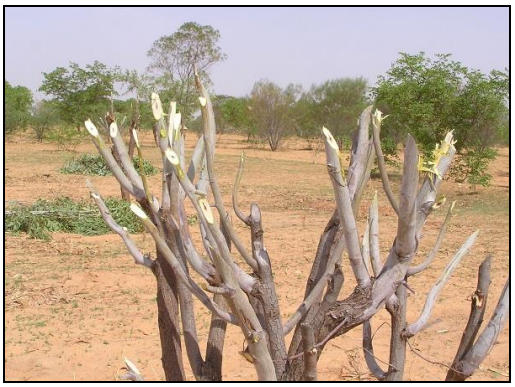
Pruning.

A well thought out pruning regime is crucial for promoting high rates of seed set and extending the trees lifespan. If the trees are left unpruned, die back and wind damage (breaking off of limbs or even uprooting of the whole tree) may begin in the third year after planting. Pruning delays die back and lessens damage from strong winds since the new branches are more flexible. Flowering and seed set are more pronounced on new branches after pruning but are negligible on the old branches of non-pruned trees. Pruning keeps seed pods within reasonable reach of farmers, few of whom have ladders.

A.torulosa. 1st pruning (3 yrs.)

A.colei 2nd pruning (2 yrs.)

A.tumida 2nd pruning (2 yrs.)



Note technique for clean cut pruning.

Timing

Pruning should be done approximately one month before the start of the rainy season. In the Maradi area- early May is the best time- farmers are not consumed with planting annual crops and excess prunings/fuel wood can be sold for much needed cash/food. These trees will then begin to re-shoot within a few weeks and more rapidly when the rains come. Good vegetative growth will occur throughout the rainy season with flowering in November/December and seed set for harvest in early/mid-March. Pruning helps to maximum seed yields.

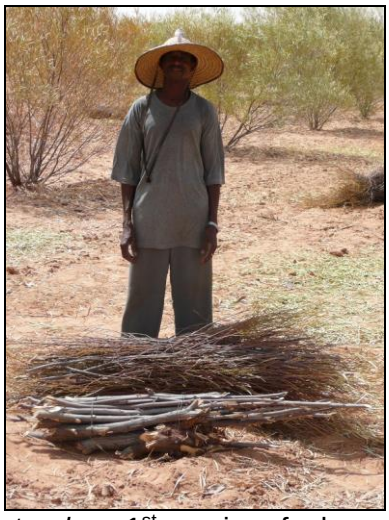
A.colei. Regrowth, 4 weeks after pruning (June)

Pruning produces mulch for soil fertility improvement

Method

Pruning all growth above 1-1.5m height with hand saws is the best way to limit damage to trees, but saws are generally not available in villages. Instead, sharp axes can be used in an upward motion to slide through branches to give a clean angled cut. Pruning in this way will lead to vigorous regrowth of multiple new seed bearing stems and heavy seed set. Traditionally farmers simply trim off all lower branches on the main stems, but regrowth from this method is not as pronounced. Smaller finger diameter branches should be left because they have a greater capacity to sprout buds and grow new shoots after pruning rather than larger branches.

A.torulosa (3 yrs.). Clean cut with axe.



A. torulosa 1st pruning- fuel wood

Frequency

A. colei and *A. torulosa* trees should be allowed to establish for two to three years (2-3 m height) before the first pruning. The best pruning regime is to prune after two-three years, then every second year thereafter depending upon the growth rates and size of trees. Farmers should be encouraged to

leave the pruned branches in the field for a few weeks so that the leaves dry. Women can then beat these braches to allow leaf matter to remain in the fields for mulching by termites.

Longevity

Pruning and tree care greatly increase longevity of *A. colei* and *A. torulosa*. One experiment established in 2001 at Danja near with both *A. colei* and *A. torulosa* spaced at 10 x 10 m and pruned after three years, then every second year thereafter (4 prunings) has >80% tree survival with most trees still producing significant biomass and seed after 12 years.

A.colei (10 yrs.), 10 x10 m spacing

A.colei (10 yrs.) 4th pruning.

Seed harvesting.

The first seed production from both *A. colei* and *A. torulosa* occurs approximately 20 months after planting. For example if seed lings are planted in July of year 1, they will establish during that rainy season, flower in November/December of year 2, and produce seed in March of year 3 (20 months).
The coiled form of *A. colei*. Var ileocarpa should be harvested when the pods are changing to a brown colour. The tree can be visited a number of times to remove the ripe pods by hand unto bags. Seed pods can then be spread to dry for 3-4 weeks away from chickens or foraging animals.
A.torulosa has an entirely different pod type which hangs from branches like cowpeas. These pods can shatter and sees fall to the ground by wind if left to long on the tree. Farmers should remove pods as they are changing colour with mature seed bulges showing in the pod. There is a narrower window of time for the *A. torulosa* seed harvest (1-2 weeks), so attention is needed to ensure pods to not dry and shatter before harvest.

A.colei seed harvest (2.5 yrs.)

Ripe *A. colei* seed retaining pods.

Ripe *A. torulosa* seed pods

Seed processing.

Once the seed pods have dried, they can be thrashed and seed cleaned for use and storage. For *A. colei*, seed pods are lightly pounded in local mortar and pestles (Tulumi- used for food preparation), then winnowed to give clean seed with arils. This seed can then we stored in bags until required for food preparation.

A.torulosa seed pods are much easier to thrash and do not produce the fine irritant dust like *A. colei* seed pods Seed pods are simply placed on hard ground or a plastic sheet and lightly beaten with sticks. The larger seed readily falls from the pods. The empty seed pods can be simply removed by hand and the seed winnowed.
One of the great strengths of acacia seed is that it can be stored for long periods (~ 5-10 years) without insect attack and yet retain its nutritive/food value.

Food preparation.

There are a range of local recipes (>40) that use acacia flour in the Maradi district. The seeds are washed, dried and ground to flour. This is best done in a mechanical mill when possible. The acacia flour is then missed with the flour of traditional grains such as millet and sorghum at a rate of no more than 25% acacia flour to 75% of other ingredients. When mixed with the main staple- millet flour at a 1:4 ration, acacia increases protein intake by 56%. Acacia seed can also be roasted and used as a coffee substitute. A baby weaning formula (Kunnu) was developed with 15% Acacia flour.

A.colei flour-seed coat removed

Acacia food demonstration

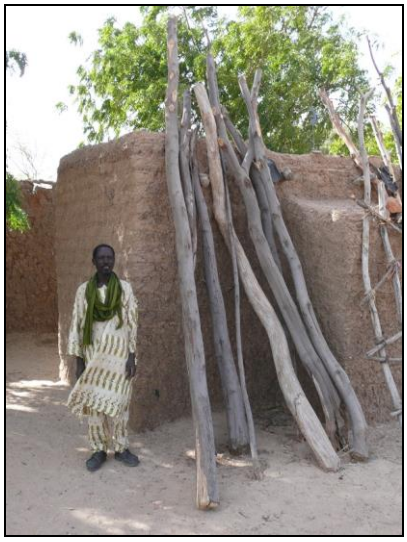
"Kunnu" Weaning formula 15% Acacia

Wood uses.

The main use of acacia wood is for fuel wood, but larger >4 yr. old branches can also be used as building timber in house construction. Farm tools- axe, hoe handles and ladders have also be constructed from acacia wood which has dense strong heart wood.

A.colei fuel wood (3 yrs.)

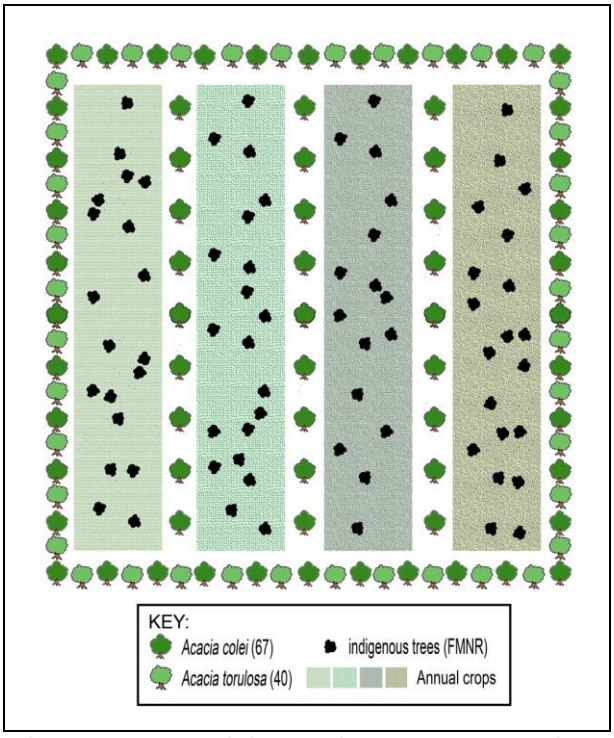
A.colei for timber/poles



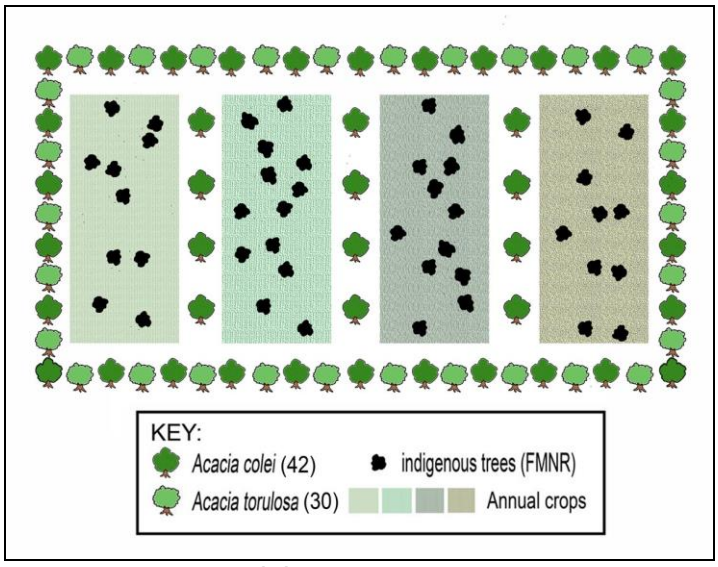
A. colei construction poles (4-5 yrs.)

Farming systems.

An integrated Agroforesry farming system called the Farmer Managed Agroforestry Farming System (FMAFS) has been developed by the Sowing Seeds of Change in the Sahel (SSCS) project in Maradi and has been showing considerable promise in capturing the benefits of multi-purpose Australian acacias such as *A. colei* and *A. torulosa*. This system incorporates FMNR, soil amelioration techniques, annual crops and multi-purpose Australian acacias in a whole farm system. Farm resilience and income are enhanced, the environment restored, biodiversity increased which in turn reduce the risk of famine. See separate Technical Note.



1 ha FMAFS model- Acacias, trees, annual crops.



½ Ha FMAFS model.

FMAFS at Danja- *A.colei* with Sorghum.

FMAFS village farm. *A. colei, A. torulosa*

Conclusion.

Edible, multi-purpose Australian acacias such as *A. colei* and *A. torulosa* may have an increasingly important role in the arid and semi-arid tropics of Africa. Their ease of propagation, rapid early growth, adaptability to a wide range of difficult sites and dry more erratic environments and high seed yield potential when minimum requirements are met (spacing, cultivation, pruning etc.) should help them to become accepted Agroforestry trees. They should be seem as a compliment to and enhance FMNR with addition services. When incorporated into Agroforestry farming systems, they can improve soil fertility and improve annual and perennial crop production and help to spread income through the range of products that the acacias provide. Some of the limitations of *A. colei* can be overcome correct silviculture: spacing, weeding and pruning and mixed planting with *A. torulosa*.

Further research is underway to evaluate a range of new provenances of *A. colei, A. torulosa* and *A. tumida*, together with a range of other edible acacia species for adaptation to drier climates (250-450 mm rainfall).