USAID KNOWLEDGE SERVICES CENTER (KSC)

Acacia (Faidherbia) albida

April 21, 2011

Acacia (Faidherbia) albida

Anne Marie Spevacek, Senior Research Analyst

KSC Research Series

ABSTRACT:

This document contains information on Acacia (Faidherbia) albida, a leguminous tree of the Mimosoideae family well known for its nitrogen-fixing benefits on soil fertility. Under F. albida's canopy, there is a two-fold statistically significant increase of soil nitrogen and organic matter. Due to the "albida effect," which refers to a remarkable increase in crop production that is the result of both increases in soil fertility and improved soil water and microclimatic conditions below the tree, F. albida has generally been protected. The reversed leaf phenology of F. albida sets it apart from other tree species that also increase soil nutrients, because it sheds its nitrogen-rich foliage during the cropping season. One of the largest trees, it is believed to be indigenous to Africa, but is also found in Israel, Syria, and Cyprus.

There is general agreement in the literature that F. albida trees do not show full benefits of nitrogen-fixing for a substantial length of time. The tree is thought to reach maturity between 7-15 years of age – however, one report estimates 20-40 years before it can influence the soil nutrients and improve crop yields. The consensus among experts is that F. albida seeds sown in nurseries can be transplanted in a field in 3-5 months. Direct seeding is viewed as yielding better results than potted seeding.

The last section contains documents from USAID's Development Experience Clearinghouse (DEC) database that are specific to F. albida.

PN-ADM-071

The USAID Knowledge Services Center is operated by Bridgeborn, Inc. and Library Associates, and funded by M/CIO/KM and M/HR/TE under contract AID-OAA-C-08-00004. The contents of this document are the sole responsibility of the Knowledge Services Center and do not necessarily reflect the views of USAID or the United States Government.

Table of Contents

Nitrogen-fixing in Acacia Faidherbia albida 2

Age of Tree Maturity, When Nitrogen-fixing Benefits Appear 4

Transplanting from Nursery to Field 5
- Propogation
- Variable Growth Pattern

USAID Documents 7

Bibliography..... 13

Additional Resources..... 14

Nitrogen-fixing in Acacia Faidherbia albida:

The benefit of F. albida (also referred to as A. albida) is its nitrogen-fixing quality, which is the result of protein-rich foliage (pods) that fall from the tree in large quantities during dormancy in the early rainy season and enrich the soil with nitrogen, phosphorus, and exchangeable calcium. Bonkoungou reports that, under the tree's canopy, total nitrogen and carbon are twice as high than outside the canopy. Jung (1967) found that F. ablida increases from 20 to 100 percent were found in nitrogen, available phosphorus, and exchangeable calcium content of the soil. In addition to yield increases, a 50 to 100 percent increase in soil organic matter and nitrogen content, a marked increase in soil microbiological activity, and an increase in water holding capacity beneath the trees has been found. Soil water retention may be as much as 43 percent higher under the canopy, and this more favorable moisture and temperature environment is thought to promote microbial decomposition and nutrient release. It is interesting to note that a 1983 report (Wentling) states that millet grown under F. albida contains 3-4 times more protein.

According to the Green Knowledge Institute, at the recommended density of 100 trees per hectare, mature F. albida trees supply the equivalent of 300 kilograms of complete fertilizer and 250 kilograms of lime, which results in an estimated 250-400 percent increase in maize yield. This so-called "albida effect" is variable – it really depends on land form, soil type, tree density, and management practices. An FAO source maintains that benefits from the tree are more pronounced in upland sites with more gravelly soil versus richer bottomland locations. F. albida is considered to be highly compatible with food crops because it does not compete with them for light. Reverse leaf phenology means it sheds its nitrogen-rich pods during the cropping season when seeds are being planted and need nitrogen. Only the bare branches of the tree's canopy spread overhead while crops grow to maturity.

Supporting information:

- "At the end of the dry season …, protein-rich pods mature and fall from the tree in large quantities. The leaf fall, root nodulation and continuous presence of livestock near the trees greatly enrich the soil by cycling the nutrients nitrogen, phosphorus and exchangeable calcium. This makes it an excellent agroforestry species as crops can be grown among scattered trees without shading during the wet season."
  Source: **FAO** http://www.betuco.be/coverfodder/Faidherbia%20albida.pdf

- Faidherbia fixes nitrogen with its roots when it is young, and later drops leaves (and pods) to transfer nitrogen and biomass.
  Source: **Natural Resources Management in African Agriculture – Understanding and Improving Current Practices** (2002)
  http://books.google.com/books?id=6C73tBxWvRkC&pg=PA121&lpg=PA121&dq=faidherbia+leaves+nitrogen+young&source=bl&ots=1YrG35R7cm&sig=yEvYV3yUzrI0Ead6mTOOdDVmc4Y&hl=en&ei=-6ClTb2WJ9CDtgerk_W6Ag&sa=X&oi=book_result&ct=result&resnum=6&ved=0CCgQ6AEwBQ#v=onepage&q=faidherbia&f=false (partial text only)

- The so-called "albida effect" is variable. Nutrient concentrations are "subject to several factors including land form, soil type, tree density and management practices. First, it is generally more pronounced in upland sites where soils tend to be more gravelly, shallower and less fertile than in the richer bottomland locations."
  Source: **Agroforestry parklands in sub-Saharan Africa** (FAO, 1999)
  http://www.fao.org/docrep/005/x3940e/X3940E00.htm#TOC (Chapter 3)

- "percentages of total nitrogen and carbon are twice as high under A**.** *albida* than outside its cover; biological activity is two to five times greater under *A. albida* than outside its cover."

Source: Sociocultural and Economic Functions of Acacia albida in West Africa (E.G. Bonkoungou) in **Faidherbia albida in the West African Semi-Arid Tropics – Proceedings of a Workshop**) in (USAID, 1991) http://pdf.usaid.gov/pdf_docs/PNABN008.pdf

- At the recommended planting density of 100 trees per hectare, mature Faidherbia albida trees supply equivalent 300kg of complete fertiliser and 250kg of lime, which result in an estimated 250-400% yield in increase in maize under a tree canopy.
  Source: **Agroforestry Part II: Faidherbia Albida** (Green Knowledge Institute, 2010) http://greenmusing.wordpress.com/2010/10/19/agroforestry-part-ii-faidherbia-albida/

- "Millet yields 2 – 2.5 times higher than those obtained on unfertilized areas not covered by F. albida are regularly achieved. Millet grown under F. albida contains 3-4 times more protein."
  Source: **Acacia albida: Arboreal Keystone of Successful Agro-Pastoral Systems in Sudano-Sahelian Africa** (USAID by Mark G. Wentling, 1983) http://pdf.usaid.gov/pdf_docs/PNAAR104.pdf

- "In addition to yield increases, a 50 to 100 percent increase in soil organic matter and nitrogen content, a marked increase in soil microbiological activity, and an increase in water holding capacity beneath the trees has been found."
  Source: **State of the Art: Acacia albida as a Complementary Permanent Intercrop with Annual Crops** (USAID by Felker, 1978) http://pdf.usaid.gov/pdf_docs/PNAAH147.pdf

- Soil water retention may be as much as 43 percent higher under the canopy, and this more favorable moisture and temperature environment is thought to promote microbial decomposition and nutrient release.
  Source: **The Potential of *Acacia albida* for Desertification Control and Increased Productivity in Chad** (USAID, by Robert D. Kirmse and Brien E. Norton, 1984) http://pdf.usaid.gov/pdf_docs/PNAAQ707.pdf (page 9)

- The Faidherbia acacia tree has the quality of "reverse leaf phenology," which drives the tree to go dormant and shed its nitrogen-rich leaves during the early rainy season - when seeds are being planted and need the nitrogen - and then to re-grow its leaves when the dry season begins and crops are dormant. This makes it highly compatible with food crops because it does not compete with them for light - only the bare branches of the tree's canopy spread overhead while crops grow to maturity. Their leaves and pods provide a crucial source of fodder in the dry season for livestock when other plants have dried up.
  Source: **PRESS RELEASE: Unique Acacia Tree Could Nourish Soils and Life in Africa** (World Agroforestry Centre, 2009). http://www.worldagroforestrycentre.org/newsroom/press-releases/press-release-unique-acacia-tree-could-nourish-soils-and-life-africa

- Research on the tree began over 60 years ago when scientists observed that farmers throughout the Sahelian region of Africa were retaining the trees in their sorghum and millet fields. It is a frequent component of farming systems of Senegal, Mali, Burkina Faso, Niger, Chad, Sudan, and Ethiopia, and in parts of northern Ghana, northern Nigeria, and northern Cameroon. The tree is growing on over 4.8 million hectares of land in Niger. Half a million farmers in Malawi and in the southern highlands of Tanzania grow the tree on their maize fields.
  Source: **PRESS RELEASE: Unique Acacia Tree Could Nourish Soils and Life in Africa** (World Agroforestry Centre, 2009). http://www.worldagroforestrycentre.org/newsroom/press-releases/press-release-unique-acacia-tree-could-nourish-soils-and-life-africa

---

Age of Tree Maturity, When Nitrogen-fixing Benefits Appear

There appears to be general agreement in the literature that F. albida trees do not show full benefits of nitrogen-fixing for a substantial length of time. Sources list the actual amount of time needed for the tree to reach maturity as anywhere in between 7-15 years of age. However, one report estimates that the trees need 20-40 years to grow to a size when they can influence the soil nutrients and improve (significantly) yields of under-planted crops. F. albida has a fast-growing (2-5 meters/year) taproot. They are one of the tallest trees in Africa, reaching a height of 20 to 30 meters and canopy diameter of 5-10 meters in 10 to 15 years.

Supporting Information:

- "Under the traditional cropping system, soil fertility is depleted after about five harvests and the farmer and his family the move on and clear a virgin or recovered field. But ***it takes F. albida about 15 years to reach maturity and produce the promised benefits***. The cooperative farmers who carefully watched over the seedlings established on their cropland for the CARE programme would have to abandon their husbandry ten years before the fruits of their labor could be fully realized. The trees protected for those four or five years would be able to make it on their own and the objectives of the project would be reach eventually, possibly at the expense of the original partnership between the donor and farmer if the latter did not return to the same field."
  Source: **The Potential of *Acacia albida* for Desertification Control and Increased Productivity in Chad** (USAID, by Robert D. Kirmse and Brien E. Norton, 1984)
  http://pdf.usaid.gov/pdf_docs/PNAAQ707.pdf (page 17)

- "Pods of *A. albida* mature slowly. In Niger, Baumer (1983) found that, under very exceptional conditions, pod development begins between the 2nd and 4th years but in general, fruit-bearing commences around the 15th year. In Senegal, Nongonierma (cited by Felker 1978) observed that the first pods appear during the eighth year; in Niger, Lemaitre (1954) observed that they appear between the 8th and the 12th year."
  Source: The Fodder Role of *Acacia albida* Del.: Extent of Knowledge and Prospects for Future Research (M.I Cisse and A.R. Kone) in **Faidherbia albida in the West African Semi-Arid Tropics – Proceedings of a Workshop**) in (USAID, 1991)
  http://pdf.usaid.gov/pdf_docs/PNABN008.pdf (page 30)

- "The absence of any significant influence of *F. albida* trees on soil at the Kenyan Coast could be attributed to the young age of the trees (4 years). Most of the other studies cited involved mature trees. This could explain why in this study [in Tanzania] involving 6-year old trees, most soil elements that are usually reported as significantly higher in the presence of *F. albida* trees were not. It could also be the reason why the yields of maize and beans that had been intercropped with the trees were hot significantly different from those in areas without the trees."
  Source: The Effect of *Faidherbiaalbida* on Soil Properties in a Semi-Arid Environment in Morogoro, Tanzania (J. Okorio) in **Faidherbia albida in the West African Semi-Arid Tropics – Proceedings of a Workshop** (USAID, 1991) http://pdf.usaid.gov/pdf_docs/PNABN008.pdf (page 119)

- The '*Faidherbia albida* effect' may require 20 to 40 years to become evident, depending on the growth rate of individual trees (Poschen, 1986). Improvement of nitrogen and potassium content under *P. biglobosa* crowns also increases with tree size.
  Source: **Agroforestry parklands in sub-Saharan Africa** (FAO, 1999)
  http://www.fao.org/docrep/005/x3940e/X3940E00.htm#TOC (Chapter 3)

- "One of the objectives of the Mouda-Gazal trial was to determine the age and stage of development at which F. *albida* has a positive effect on soil fertility and yields of associated crops.

After 5 years of growth, tree crowns were small and low foliar biomass production had no discernable positive impact on soil fertility or crop yields. In fact, the tree density (500 trees ha-') hindered plowing operations and diminished arable area."
Source: *Faidherbia albida* in Northern Cameroon: Provenance Trials and Crop Associations (J.M. Harmand and C.F. Njiti) in **Faidherbia albida in the West African Semi-Arid Tropics – Proceedings of a Workshop** (USAID, 1991) http://pdf.usaid.gov/pdf_docs/PNABN008.pdf (page 81)

- According to Chikondi Lilian Phiri, an extension officer and trainer at the Conservation Farming Unit, full benefits of Faidherbia Albida's nitrogen-fixing qualities don't appear until after 7-15 years, so it does not have an immediate benefit to farmers.
  Source: **Plant your own Fertiliser Factory** (Agfax, January 2010) http://www.agfax.net/transcript/agfax305.doc

- "F. albida has a fast-growing (2-5 m/year) taproot which grows straight down for over a meter before branching out, reaching up to 30 meters; therefore, there is not any competition with annual crops for surface-soil nutrients and water, and it does not interfere with cultivation."
  Source: **Acacia albida: Arboreal Keystone of Successful Agro-Pastoral Systems in Sudano-Sahelian Africa** (USAID by Wentling, 1983) http://pdf.usaid.gov/pdf_docs/PNAAR104.pdf

---

Transplanting from Nursery to Field:

There is a lack of agreement in the literature regarding how long F. albida should remain in nursery before being transplanted into a field. Sources indicate anywhere between 10 weeks and six months, but the general consensus appears to be 3-5 months. One article cited below (Louppe and Ouattara) states that leaving seedlings in a nursery for a long time is unnecessary and undesirable. It maintains that seedlings suitable for planting can be produced in a nursery in less than 2 months, and because young seedlings – versus older root-pruned – regenerate their taproots better, after 52 days the seedlings begin to deteriorate. A trial run by Torrekens, Lemane, and Gambo outplanted seedlings at 10 weeks. Another source (McGahuey) advocates for 3-4 months. Ducoussot and Colonna state that 12 weeks is the minimum time required for F. albida to be in a nursery.

Felker reports that F. albida seeds sown in the nursery in April or May are transplanted in August or September (4-5 months). He presents a specific methodology for better seed survival – 90 percent at the end of the dry season and 75 percent 15 months later. This involves harvesting fresh seeds from pods in April; treating the seeds with boiling water; sowing the seeds in polyethylene bags 30 cm deep; and in early August transplanting to the field.

Supporting Information:

- "Seeds can be sown directly or nursery planted, ideally using long poly tubes (30x8 cm), with regular watering and frequent mechanical root or air root pruning (CTFT 1988). Seedlings can be transplanted 3-6 months later. Spacing at 10x10 m is common, but varies with moisture availability and local farming traditions."
  Source: **Faidherbia Albida – inverted phenology supports dryzone agroforestry** (NTF Highlights, January 1995) http://www.winrock.org/fnrm/factnet/factpub/FACTSH/F_albida.html

- "Seedlings were raised in a nursery and outplanted at 10 weeks in Jul 1984."
  Source: Trial of Nine *Acacia albida* Provenances in Dosso, Niger (P. Torrekens, I. Lemane, and S. Gambo) in **Faidherbia albida in the West African Semi-Arid Tropics – Proceedings of a Workshop** (USAID, 1991) http://pdf.usaid.gov/pdf_docs/PNABN008.pdf (page 77)

- "… 20-cm tall seedlings suitable for planting could be produced in the nursery in less than 2 months. Seedlings were naturally inoculated and the nodules were active. It appears to be unnecessary and perhaps undesirable to keep the plants longer in the nursery for two reasons. Firstly, … young root-pruned *F. albida* seedlings regenerate their taproots better than older root-pruned seedlings. Secondly, … after day 52, fine roots on the upper part of taproots appeared to decrease in number to the point where their activity no longer seemed functional. Nodules in this root zone declined at the same time, and by day 60 had blackened. These superficial fine roots and nodules survive for a shorter period than previously thought."
  Source: Growth of *Faidherbia albida* in Nurseries: Standard Production Techniques or Air Pruning? (D. Louppe and N'KIo Ouattara) in **Faidherbia albida in the West African Semi-Arid Tropics – Proceedings of a Workshop** (USAID, 1991) http://pdf.usaid.gov/pdf_docs/PNABN008.pdf (page 141)

- Twelve weeks is the minimum time required in the nursery for *F. albida.* These data show that, in this time, the average seedling grown in I-L [one liter] pots would have a 32-cm taproot and a root biomass of 0.75 g for the noninoculated control or 1.08 g for inoculated plants. To reduce or eliminate production time in the nursery and to take advantage of the growth potentials demonstrated by these experiments, use of larger containers, or even direct seeding, is a preferable alternative."
  Source: Endomycorrhiza Infection in Young Faidherbia albida: Influence on Growth and Development (M. Ducoussot and J.P. Colonna) in **Faidherbia albida in the West African Semi-Arid Tropics – Proceedings of a Workshop** (USAID, 1991) http://pdf.usaid.gov/pdf_docs/PNABN008.pdf (page 154)

- "Seedling size. It is possible that the larger seedlings survived better; 3-4 months' growth in the nursery seemed ideal."
  Source: Extension of *Acacia albida:* Recapitalization of the Natural Resource Base (M. McGahuey) in **Faidherbia albida in the West African Semi-Arid Tropics – Proceedings of a Workshop** (USAID, 1991) http://pdf.usaid.gov/pdf_docs/PNABN008.pdf (page 162)

- A method reported to yield 90% seedling survival at the end of the dry season and 75% survival 15 months later (Giffard, 1964) involved: harvesting fresh seeds from pods in April; treating the seeds with boiling water; sowing the seeds in polyethylene bags 30 cm deep; and in early August transplanting to the field.. Lemaitre (1954) also found that 7 August was the best transplanting date for A. albida seedlings."
  Source: **STATE OF THE ART: Acacia Albida as a Complementary Permanent Intercrop with Annual Crops** (USAID by Felker, 1978) http://pdf.usaid.gov/pdf_docs/PNAAH147.pdf (page 96)

Also see: **Propagation**

A number of sources indicate that direct seeding yields better results. Louppe and Ouattara, for instance, found that F. albida trees grown in pots are inferior to those directly seeded 6 months after sowing. As well, a low seed germination rate (60 percent) and a high tree mortality (30-40 percent) require planting many more trees in nursery and in the field then needed. High heterozygosity in seedlings also results in large variance in growth rate which requires selective transplanting to the field.

Supporting information:

- "For all the parameters studied, direct seeding gave the best results. Favorable conditions at the time of seeding, however, were critical for the success of this technique. Besides the clear superiority of direct seeding over potted seedlings in terms of growth (Table I), survival rates of direct-seeded plants were much higher. At month 6, direct seeding of three pregerminated seeds per hill had a 48% higher survival rate than potted seedlings raised 2.5 months in the nursery."

Source: Regeneration of *Acacia albida* with Direct Seeding (S.A.N. Samba) in **Faidherbia albida in the West African Semi-Arid Tropics – Proceedings of a Workshop** (USAID, 1991) http://pdf.usaid.gov/pdf_docs/PNABN008.pdf (page 139)

- "Nursery production techniques for *Faidherbia albida* have yet to be optimized. Cazet (1987) demonstrated that root systems of *F. albida* grown in pots are inferior to those of direct seeded plants 6 months after sowing."
  Source: Growth of *Faidherbia albida* in Nurseries: Standard Production Techniques or Air Pruning? (D. Louppe and N'KIo Ouattara) in **Faidherbia albida in the West African Semi-Arid Tropics – Proceedings of a Workshop** (USAID, 1991) http://pdf.usaid.gov/pdf_docs/PNABN008.pdf (page 141)

- Propagation in the traditional agrosystems was done from naturally grown seedlings in millet fields, selected and nurtured by the farmers until they reach a size above the reach of livestock (0.5-0.8 m per year). Direct seeding of pregerminated seeds was very successful in Senegal (Cazet, 1987, 1988; Cazet & Sadio, 1988) and should be encouraged for its low cost, and therefore sustainability. But direct seeding has also a constraint as it requires a careful weeding in the young stages of establishment, to avoid competition for water.
  Source: **FAO** http://www.fao.org/ag/AGP/AGPC/doc/GBASE/data/pf000095.htm

- "[F.] albida seeds can be artificially germinated by treating with boiling water and nicking the seed coat. However, a low seed germination rate (60%) and a high tree mortality (30-40%) require planting many more trees in nursery and in the field then [is] needed (Weber, 1871, 1978). Also, high heterozygosity in seedlings results in large variance in growth rate which requires selective transplanting to the field (Aloni, 1972)."
  Source: **Acacia albida: Arboreal Keystone of Successful Agro-Pastoral Systems in Sudano-Sahelian Africa** (USAID by Wentling, 1983) http://pdf.usaid.gov/pdf_docs/PNAAR104.pdf

And: **Variable Growth Pattern**

- S.C. Geiger et al. highlight the variable growth pattern (i.e., erratic tree establishment) of F. albida. They cite this as the primary cause for mixed results when attempts were made to plant *F. albida* in farmers' fields in West Africa to increase total system productivity and therefore crop yield.
  Source: Geiger, SC, RJ Vandenbeldt, and A. Manu. 1991. **Preexisting Soil Fertility and the Variable Growth of *Faidherbiaalbida*** (in Faidherbia albida in the West African Semi-Arid Tropics – Proceedings of a Workshop. USAID). http://pdf.usaid.gov/pdf_docs/PNABN008.pdf (page 121)

USAID Documents:

*PN-ABN-008 Conference Proceedings/Paper
Faidherbia albida in the West African semi-arid tropics: proceedings of a workshop, 22-26 Apr 1991, Niamey, Niger
Vandenbeldt, R. J., ed.
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
International Council for Research in Agroforestry (ICRAF)
USAID. Bur. for Research and Development. Ofc. of Agriculture (Sponsor)
1992, v, 206 p. [193 p.] : ill., charts, statistical tables, [ICR no.] 92-060
ISBN: 9290662204
Workshop on Faidherbia albida in the West African Semi-Arid Tropics (22-26 Apr 1991: Niamey, NG)
Project title: International agricultural research centers (IARCS)
Project No: 936411106

*Availability: International Council for Research in Agroforestry
http://pdf.usaid.gov/pdf_docs/PNABN008.pdf (5,036 KB)
This workshop brought together scientists and development workers, primarily those working in the West Africa region, to review past and present research findings on Faidherbia albida (also known as Acacia albida); discuss development issues and lessons learned from past and present; list research priorities for the future; and promote collaboration between research and development programs. These proceedings summarize the state of knowledge on the species and provide a comprehensive list of ongoing research. Papers are divided into sessions on: botany and distribution; uses; genetics; provenance trials and vegetative propagation; site effects, silviculture, and rhizosphere; and development issues. Recommendations from Working Groups for future research and multidisciplinary linkages are included. (Author abstract)
Descriptors: Acacia albida trees; Agroforestry; Grazing land; Agricultural research Plant genetics; Botany; Cropping systems; Plant propagation; Soil management; Biogeography; Silviculture; Soil fertility; Socioeconomic aspects; Cultural anthropology West Africa; Sahel
---
PD-ABC-420 Special Evaluation
Senegal reforestation project, contract no. 685-0283: mid-term evaluation
Karch, G. Edward; Dieng, Ndiawar; et al.
Chemonics International Consulting Div.
USAID. Mission to Senegal (Sponsor)
8 Mar 1991, vi, 36 p. + 5 annexes [76 p.] : statistical tables
Delivery order no. 2
Project title: Senegal reforestation project
Project No: 6850283
PDC-1406-I-02-0033-00
http://pdf.usaid.gov/pdf_docs/PDABC420.pdf (1,199 KB)
Mid-term evaluation of a project to encourage tree planting by groups and individuals in Senegal. External evaluation covers the period 8/86-11/90. Although the project goal and purpose remain valid, they are not achievable by the PACD. The time frame is too short for a forestry project, long-term TA needs were underestimated, and assumptions regarding training needs of the forestry service were unrealistic. Nonetheless, the project team is technically and administratively competent and continued support is warranted. The matching grants for on-farm forestry component has undergone considerable restructuring in response to studies conducted under the project. It is planned to use matching grant funds for interventions in Acacia albida, block plantation of eucalyptus, and fruit and nut trees. By PACD, some 2,816 grants should be made, leading to the planting of some 4,000 ha.

In the training and extension component, technical expertise for interventions other than block plantations has been weak. While this may be improved as the training program progresses, additional TA should be provided. Five participants have begun M.S. programs, and twelve seminars have been held for forestry agents. The media campaign has focused primarily on delivering public service messages, with little attention to developing training materials. Some progress has been made in roadside planting (30 km vs. 200 planned), but this is a new approach to tree planting and time will be needed to work out related problems.

Progress has been made in promoting private sector involvement in forestry by conducting basic market studies and disseminating information to the field. Connections between producers and buyers are beginning to improve. Under the policy review component, the project has also provided information support to government policymakers by conducting a study on the forestry code.

Descriptors: Agroforestry; Forestry; Matching funds; Agricultural extension training; IEC; Private sector; Policy analysis Development project design; Marketing research; Farmer training; Farmer participation; Acacia albida trees; Fruit trees; Eucalyptus trees; Planting Senegal
Identifiers: Interim evaluation

PD-AAX-873 Special Evaluation

Comprehensive report and evaluation: cereals production II (685-0235), project extension (March 1985-December 1987), USAID/Senegal

Freeman, Peter H.; Tejeda, Felipe
Labat-Anderson, Inc.
USAID. Mission to Senegal (Sponsor)
[1988], viii, [42] p. + 11 annexes [79 p.] : statistical tables
French ed.: PD-AAX-874
Project No: 6850235
http://pdf.usaid.gov/pdf_docs/PDAAX873.pdf

Final evaluation of a pilot activity (financed under a 4/85-12/87 project extension) to conduct research, training, and extension in agroforestry (AF) and soil conservation (SC) techniques in sixty villages in the regions of Thies and Diourbel in central Senegal. Results were mixed. AF targets for tree planting, extension, and training met with good success. Woodlots were started in many project villages; survival rates ranged from 60% in better protected woodlots to 34% in double line windbreaks. Natural regeneration of Kad (Acacia albida) had an 89% survival rate. AF training events for extensionists were held both in-country and through short-term study tours in the United States. Project personnel also benefited from stateside training in information management and farming systems research. Extension activities in project villages (e.g., woodlots, orchards, windbreaks, windrows, individual plantings, live fencing) were successful as well, although a complicating factor was the lack of water and materials for compost pit construction and well digging.

On the other hand, soil and water conservation activities did not take place as planned, due to problems with local contractors, and there was only marginal success in developing AF and SC techniques. Funds programmed for adaptive research were used instead for technical studies carried out by Senegalese firms. Collaboration among the six different agencies involved in the project was complicated by budget restrictions, and research-extension cooperation did not occur as designed. In fact, project management proved to be the most challenging aspect of this pilot effort, due to the project's small size and diversity, the number of participating agencies, and USAID/S's direct procurement approach.

Some 15 lessons are gleaned from this project; they stress the need for streamlined, field-based management procedures, the importance of considering village dynamics when designing AF projects of this type, and the need to develop more sophisticated improved maintenance procedures for tree plantings. Other specific lessons are that (1) simply planting trees does not adequately demonstrate their value; (2) tree protection is a good indicator of village interest in different plantings and species; (3) barbed wire fencing is probably easier and cheaper to use than local fencing materials; (4) SC activities require accurate data, so preliminary studies should be performed before these activities are designed; and (5) AF is not a sufficient response to the problems of soil degradation.

Descriptors: Agroforestry; Soil conservation; Soil research; Pilot projects; Agricultural extension training; Agricultural extension Trees; Windbreaks; Agricultural research; Water conservation; Coordinating; Villages; Soil depletion; Environmental degradation; Natural resource management; Acacia albida trees Senegal
Identifiers: Scheduled evaluation; Final evaluation

---

*PN-ABC-665 Periodical/Periodical Analytic

Acacia albida and other multipurpose trees on the fur farmlands in the Jebel Marra highlands, western Darfur, Sudan

Miehe, S.
International Council for Research in Agroforestry (ICRAF)
USAID. Bur. for Science and Technology. Ofc. of Agriculture (Sponsor)

Agroforestry systems, no. 4
1986, p. 89-119 [16 p.] : ill.
Contribution no. 16 of the series on Agroforestry system descriptions
Duplicate project number. See PROJECTS data base abstract for explanation.
Project No: 9365545; 9365545A
*Availability: International Council for Research in Agroforestry
http://pdf.usaid.gov/pdf_docs/PNABC665.pdf (770 KB)
Descriptors: Agroforestry; Mixed cropping
Cropping systems; Traditional farming; Ethnic groups; Farm management; Research planning Sudan
---

PN-AAQ-707 Periodical/Periodical Analytic
Potential of Acacia albida for desertification control and increased productivity in Chad
Kirmse, Robert D.; Norton, Brien E.
Biological conservation, v. 29
1984, p. 121-141 [21 p.]
http://pdf.usaid.gov/pdf_docs/PNAAQ707.pdf (606 KB)
Descriptors: Desertification; Reforestation; Acacia albida trees Agroforestry; Plantations; Land management; Community participation; Development projects Sahel; Chad
---

PN-AAR-104 Other USAID Supported Study/Document
Acacia albida: arboreal keystone of successful agro-pastoral systems in Sudano - Sahelian Africa
Wentling, Mark G.
Cornell University. Dept. of Animal Science
USAID. Bur. for Science and Technology. Ofc. of Agriculture (Sponsor)
3 May 1983, 22 p. + 7 appendices [41 p.]
http://pdf.usaid.gov/pdf_docs/PNAAR104.pdf (1,058 KB)
Descriptors: Forestry; Acacia albida trees; Farming systems; Crop-animal systems Livestock; Cropping systems; Agronomy; Animal nutrition; Botany; Browsing; Nutrients Sahel
---

PD-AAG-828 USAID Contract/Grant Agreement
AFRICARE; GRANT AID/AFR-G-1655
SNYDER, MICHAEL H.
USAID. Bur. for Program and Management Services. Ofc. of Contract Management
28 May 1980 [10 p.], AID/AFR-G-1655
Project No: 6850243
http://pdf.usaid.gov/pdf_docs/PDAAG828.pdf
Operational program grant is provided to Africare to assist the Government of Senegal in establishing a village reforestation program. Africare will provide financing for 20-acre (13,000 trees) woodlots to be established in each of five villages. Nursery supplies and equipment, plantation hand tools, and additional seedlings (to replace those that die after the first year) will also be provided. The woodlots will be prepared in cooperation with (and eventually turned over to) village quasi-cooperatives and will provide firewood, while alleviating soil erosion and protecting against drought. The trees will be started as seedlings in nearby nurseries. After attaining sufficient height and maturity, the seedlings will be transported by the Foresty Service to plots prepared by the villagers. Fast-growing species such as "Eucalyptus camaldulensis" and "Azidirachta Indica" will be planted. Other species such as "Prosopis juliflora", "Pithecellobium dulce", "Cassia Siamea", "Acacia albida" (cadd), "Anacardium occidentale" (cashew) will be grown to provide products for construction, food, grazing, shade, windbreaks, medicine, ropes, dyes, soap, etc. The Forestry Service will train and supervise the villagers in nursery management. In addition, visits by extension agents and other support will be provided in subsequent years.

Descriptors: Rural development; Forest products; Forests; Plantations; ENERGY; Firewood; Energy resource development; Energy farming; Renewable energy resources; ECOLOGY; Trees; Indigenous education; Seedlings; Forestry; Private voluntary organizations Senegal
---

PD-AAJ-854 Special Evaluation

Chad reforestation project; midpoint evaluation

Weber, Fred R.; Dulansey, Maryanne
Consultants in Development
CARE International (Sponsor)
Apr 1978, 52 p. + appendices [90 p.]
Project No: 6770008
http://pdf.usaid.gov/pdf_docs/PDAAJ854.pdf (2,075 KB)

Evaluates project to establish the Acacia albida tree in Chad to increase agricultural production and promote firewood cultivation. Special evaluation covers the period 7/76-4/78 and is based on document review; field visits; and interviews with CARE, Peace Corps, USAID/C, and other project personnel, and participating farmers. The project is an outstanding success in terms of progress toward achieving outputs and is in fact ahead of schedule in all areas except live fencing. This is in part due to farmers' unfamiliarity with the concept of live fencing and is not a great problem since the available species has not proven completely satisfactory. Output levels attained thus far include: 350,500 acacia trees versus a planned total of 350,000 planted on 2,000 ha, with 178,000 surviving; 45,000 of a planned 122,500 m of Commiphora tree fencing planted; 63,000 trees planted (52,500 still living) as windbreaks and for firewood; and nine nurseries established. A field manual and a series of films have also been prepared. Now that targets have been achieved, more attention should be given to increasing the survival rate and protection of the trees. Approximately 3,000 farmers versus an expected 1,850 are participating in the project. Virtually all have received some P.L. 480 and CARE foodstuffs, and some have also been provided tools. However, these "incentives" have not been given in such a way as to encourage cooperation and performance, indicating a need to revise the food for work system. Among the technical issues addressed by the evaluators were the durability of the plastic pots and bags in which the nurseries plant the trees; the advantages of seed planting over stock planting; the trees' impact on the water table; the possibility of using vegetatitive reproduction of acacia; methods of rainwater harvesting; tree growth rates; choice of species for live fencing; and damage from elephants and caterpillars.

A series of 20 recommendations are made for improving the project regarding the types and numbers of trees still to be planted, planting techniques, development of educational materials, and improved communication among project personnel.

Descriptors: Acacia albida trees; Reforestation
Windbreaks; Forests; Plantations; Firewood; Food for work; Small farms; Farmers Chad
Identifiers: Indepth evaluation; Onsite evaluation; Evaluation team
---

PN-AAH-147 Other USAID Supported Study/Document

STATE OF THE ART: ACACIA ALBIDA AS A COMPLEMENTARY PERMANENT INTERCROP WITH ANNUAL CROPS

FELKER, PETER
University of California, Riverside. College of Natural and Agricultural Sciences
1978 [143 p.]
Project No: 6250926
AID/afr-C-1361
http://pdf.usaid.gov/pdf_docs/PNAAH147.pdf (4,755 KB)

Acacia albida, a leguminous tree, has substantially increased the well-being of small farmers in the Sahelian desert region of West Africa by increasing soil fertility and crop yields and by providing pods for animal food. Although the available literature does not allow a completely accurate analysis of its

actual and potential capabilities, it is reported that use of A. albida for foliage cover in intercropped systems on infertile soils has nearly doubled yields of millet and peanuts. Such use also reportedly increases the soil's organic matter and nitrogen content, soil microbiological activity, and water holding capacity beneath the trees. It has also been suggested, though not proven, that A. albida has increased the capacity of the land to support people from about 10-20 to 25-40 persons per square kilometer. By making unnecessary the continual process of letting mineral-depleted land lie fallow and clearing new land, A. albida is also credited with making possible permanent agricultural settlements.

These are the major findings of the state-of-the-art review of the A. albida literature presented in this document. The text begins with the extensive literature review itself and then summarizes the effects of A. albida on crop yield and soil properties, the causes for A. albida-induced soil fertility, its pod yields and food values, and its growth cycle characteristics. The paper concludes with a discussion of ten areas in which, in the opinion of the author, research is urgently needed, either to anticipate and solve A. albida problems before they arise in the field, or to develop better agricultural practices and A. albida cultivars. Two appendices containing interviews with Senegalese farmers and with researchers in Paris and in Senegal concerning A. albida are also included. A forward describes the method in which the documents (copies of which are now all deposited at the University of California, Riverside Library) contained in this literature review were obtained.
Descriptors: NITROGEN FIXATION; AGRICULTURAL RESEARCH; AGRICULTURAL PRODUCTION; INTERCROPPING; SOIL FERTILITY; Millet; Leguminous crops; Acacia albida trees
---

PD-AAM-526 Miscellaneous Document
Acacia Albida expansion project: a field manual
McGahuey, Michael; Kirmse, Robert
CARE International
USAID. Mission to Chad (Sponsor)
Chad. Ministry of Natural Resources (Sponsor)
1977 [131 p.]
Project No: 6770008
AID/afr-G-1251
http://pdf.usaid.gov/pdf_docs/PDAAM526.pdf
Descriptors: Land development; Acacia albida trees; Cropping patterns; Agricultural production; Agroforestry Chad
---

PD-AAG-386-A1 USAID Contract/Grant Agreement
OPG ACACIA ALBIDA EXPANSION PROJECT PROPOSAL: PVO CARE
CARE International
2 Jun 1976, 20 p. + annex, AID/AFR-G-1252
Project No: 6770008
http://pdf.usaid.gov/pdf_docs/PDAAG386A1.pdf
OPERATIONAL PROGRAM GRANT PROVIDED TO CARE, INC, TO ESTABLISH THE USE OF THE ACACIA ALBIDA TREE AS A RECONGNIZED, LOW-COST WAY OF INCREASING GRAIN/YIELDS FOR SUBSISTENCE FARMERS IN CHAD. THE PRINCIPAL OUTPUT WILL BE THE PLANTING OF 3,500 HECTARES WITH 350,000 ACACIA ALBIDA TREES (ONE FOR EVERY SQUARE 10 METERS). EACH OF THE 1,750 PARTICIPATING FARMERS WILL BE SUPPLIED WITH HAND TOOLS FOR PREPARING THE GROUND, PLANTING THE TREES, AND MAKING A BARBED WIRE FENCE AROUND EACH. "FOOD-FOR-WORK" AND CASH REMUNERATION WILL BE PROVIDED. GRAIN YIELDS IN FIELDS PLANTED WITH ACACIA ALBIDA ARE EXPECTED TO INCREASE BY 50% WITHIN 10 YEARS. ALL OTHER OUTPUTS ARE PRIMARILY DESIGNED TO ENSURE THAT THE ACACIA ALBIDA TREES WILL NOT BE LOST, EITHER TO WIND EROSION, BROWSING, OR FOR USE AS FIREWOOD, THUS, 122,500 METERS OF LIVE FENCING USING COMIPHORA TREES (6 TO THE METER, OR A TOTAL OF 735,000 TREES) WILL BE PLANTED AROUND THE FIELDS. 105,000 METERS OF NEEM TREES WILL BE PLANTED (ONE TREE EVERY 2 METERS, OR 52,500 TREES) FOR USE AS WINDBREAKS AND FIREWOOD. 8 TREE NURSERIES WILL BE ESTABLISHED TO PROVIDE SEEDLINGS. CARE WILL MANAGE THE PROJECT AND PREPARE

EDUCATIONAL MATERIALS AND A FIELD MANUAL. MINISTRY OF AGRICULTURE FORESTRY AGENTS AND LOCAL FARMER SUPERVISORS WILL BE TRAINED. ONCE THE CONCEPT IS WELL ESTABLISHED, THE PROJECT CAN BE TAKEN OVER ENTIRELY BY THE MOA FORESTRY DIVISION.

Descriptors: Private voluntary organizations; Forestry; Agricultural training; Forests; Plantations; Food production; Acacia albida trees; Farmer training; Nonformal education; Agricultural production; Agricultural technology; Agricultural inputs; Subsistence farming; FOOD FOR WORK; Seedlings; FIREWOOD; Soil conservation; Cereals; Crop production; Afforestation; Management training Chad

---

Bibliography

AGFAX. January 2010. **Plant your own Fertiliser Factory**. http://www.agfax.net/transcript/agfax305.doc

Brendan Barrett, Christopher, Dr. Frank Place, and Abdillahi A. Aboud. 2002. **Natural Resources Management in African Agriculture – Understanding and Improving Current Practices.** http://books.google.com/books?id=6C73tBxWvRkC&pg=PA121&lpg=PA121&dq=faidherbia+leaves+nitrogen+young&source=bl&ots=1YrG35R7cm&sig=yEvYV3yUzrI0Ead6mTOOdDVmc4Y&hl=en&ei=-6ClTb2WJ9CDtgerk_W6Ag&sa=X&oi=book_result&ct=result&resnum=6&ved=0CCgQ6AEwBQ#v=onepage&q=faidherbia&f=false (partial text only)

Bonkoungou, E. G. 1991. **Sociocultural and Economic Functions of Acacia albida in West Africa** (in Faidherbia albida in the West African Semi-Arid Tropics – Proceedings of a Workshop. USAID.) http://pdf.usaid.gov/pdf_docs/PNABN008.pdf

Cisse, M.I., and A.R. Kone. 1991. **The Fodder Role of *Acacia albida* Del.: Extent of Knowledge and Prospects for Future Research** (in Faidherbia albida in the West African Semi-Arid Tropics – Proceedings of a Workshop. USAID). http://pdf.usaid.gov/pdf_docs/PNABN008.pdf

Ducoussot, M. and J.P. Colonna. 1991. **Endomycorrhiza Infection in Young Faidherbia albida: Influence on Growth and Development** (in Faidherbia albida in the West African Semi-Arid Tropics – Proceedings of a Workshop. USAID). http://pdf.usaid.gov/pdf_docs/PNABN008.pdf

Felker, Peter. 1978. **STATE OF THE ART: Acacia Albida as a Complementary Permanent Intercrop with Annual Crops**. USAID. http://pdf.usaid.gov/pdf_docs/PNAAH147.pdf

Geiger, SC, RJ Vandenbeldt, and A. Manu. 1991. **Preexisting Soil Fertility and the Variable Growth of *Faidherbiaalbida*** (in Faidherbia albida in the West African Semi-Arid Tropics – Proceedings of a Workshop. USAID). http://pdf.usaid.gov/pdf_docs/PNABN008.pdf

Green Knowledge Institute. 2010. **Agroforestry Part II: Faidherbia Albida** http://greenmusing.wordpress.com/2010/10/19/agroforestry-part-ii-faidherbia-albida/

Harmand, J. M. and C. F. Njiti. 1991. ***Faidherbia albida* in Northern Cameroon: Provenance Trials and Crop Associations** (in Faidherbia albida in the West African Semi-Arid Tropics – Proceedings of a Workshop. USAID) http://pdf.usaid.gov/pdf_docs/PNABN008.pdf

Kirmse, Robert D. and Brien E. Norton. 1984. **The Potential of *Acacia albida* for Desertification Control and Increased Productivity in** Chad. USAID. http://pdf.usaid.gov/pdf_docs/PNAAQ707.pdf

Louppe, D. and N'Klo Ouattara. 1991. **Growth of *Faidherbia albida* in Nurseries: Standard Production Techniques or Air Pruning?** (in Faidherbia albida in the West African Semi-Arid Tropics – Proceedings of a Workshop. USAID). http://pdf.usaid.gov/pdf_docs/PNABN008.pdf

McGahuey, M. 1991. **Extension of *Acacia albida:* Recapitalization of the Natural Resource Base** (in Faidherbia albida in the West African Semi-Arid Tropics – Proceedings of a Workshop. USAID) http://pdf.usaid.gov/pdf_docs/PNABN008.pdf

NTF Highlights. 1995. **Faidherbia Albida – inverted phenology supports dryzone agroforestry** http://www.winrock.org/fnrm/factnet/factpub/FACTSH/F_albida.html

Okorio, J. 1991. **The Effect of *Faidherbiaalbida* on Soil Properties in a Semi-Arid Environment in Morogoro, Tanzania** (in Faidherbia albida in the West African Semi-Arid Tropics – Proceedings of a Workshop. USAID). http://pdf.usaid.gov/pdf_docs/PNABN008.pdf

Sambia, SAN. 1991. **Regeneration of *Acacia albida* with Direct Seeding** (in Faidherbia albida in the West African Semi-Arid Tropics – Proceedings of a Workshop. USAID) http://pdf.usaid.gov/pdf_docs/PNABN008.pdf

Torrekens, P., I. Lemane, and S. Gambo. 1991. **Trial of Nine *Acacia albida* Provenances in Dosso, Niger** (in Faidherbia albida in the West African Semi-Arid Tropics – Proceedings of a Workshop. USAID). http://pdf.usaid.gov/pdf_docs/PNABN008.pdf

United Nations Food and Agriculture Organization (FAO). 1999. **Agroforestry parklands in sub-Saharan Africa**. http://www.fao.org/docrep/005/x3940e/X3940E00.htm#TOC

--------. No date. http://www.betuco.be/coverfodder/Faidherbia%20albida.pdf

Wentling, Mark G. 1983. **Acacia albida: Arboreal Keystone of Successful Agro-Pastoral Systems in Sudano-Sahelian Africa**. USAID. http://pdf.usaid.gov/pdf_docs/PNAAR104.pdf

World Agroforestry Centre. 2009. **PRESS RELEASE: Unique Acacia Tree Could Nourish Soils and Life in Africa**. http://www.worldagroforestrycentre.org/newsroom/press-releases/press-release-unique-acacia-tree-could-nourish-soils-and-life-africa

---

Additional Resources

Campa, Claudine, et al. September 2000. **Differences in Nitrogen Metabolism of Faidherbia albida and Other N2-Fixing Tropical Woody Acacias Reflect Habitat Water Availability**. *New Phytologist*, Vol. 147, No. 3, pp. 571-578.

Cutler, D. F. 1969. **The Vegetative Anatomy of Acacia albida Del**. *Kew Bulletin*, Vol. 23, No. 2, pp. 203-208.

Dewees, Peter A. January 1995. **Trees on farms in Malawi: Private investment, public policy, and farmer choice.** International Food Policy Research Institute (IFPRI). http://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID1292440_code430675.pdf?abstractid=1292440&mirid=1

Dunham, Kevin. May 1991. **Comparative Effects of Acacia albida and Kigelia africana Trees on Soil Characteristics in Zambezi Riverine Woodlands**. J*ournal of Tropical Ecology*, Vol. 7, No. 2, pp. 215-220.

--------. May 1989. **Litterfall, Nutrient-Fall and Production in an Acacia albida Woodland in Zimbabwe**. *Journal of Tropical Ecology*, Vol. 5, No. 2, pp. 227-238.

Kristensen, Metus and Anne Mette Lykke. Summer 2003. **Informant-Based Valuation of Use and Conservation Preferences of Savanna Trees in Burkina Faso**. *Economic Botany*, Vol. 57, No. 2, pp. 203-217.

Midgley, JJ and WJ Bond. November 2001. **A Synthesis of the Demography of African Acacias**. *Journal of Tropical Ecology*, Vol. 17, No. 6, pp. 871-886.

Munzbergova, Zuzana and David Ward. April 2002. **Acacia Trees as Keystone Species in Negev Desert Ecosystems**. *Journal of Vegetation Science*, Vol. 13, No. 2, pp. 227-236. PDF attached.

Payne, WA and JH Williams. November/December 1998. **Crop diversification in the Sahel through use of environmental changes near Faidherbia albida**. *Crop Science*, Vol. 38 Issue 6. Abstract available at: http://cat.inist.fr/?aModele=afficheN&cpsidt=1632185

Radwanski, S.A. and G.E. Wickens. November 1967. **The Ecology of Acacia albida on Mantle Soils in Zalingei, Jebel Marra, Sudan**. *Journal of Applied Ecology*, Vol. 4, No. 2, pp. 569-579.

Roupsard, O, et al. August 1999. **Reverse Phenology and Dry-Season Water Uptake by Faidherbia albida (Del.) A. Chev. in an Agroforestry Parkland of Sudanese West Africa**. *Functional Ecology*, Vol. 13, No. 4, pp. 460-472.

Wickens, G. E. 1969. **A Study of Acacia albida Del. (Mimosoïdeae)**. *Kew Bulletin*, Vol. 23, No. 2 (1969), pp. 181-202.

U.S. Agency for
International Development
1300 Pennsylvania Avenue NW
Washington, DC 20523
Tel: 202-712-0000
Fax: 202-216-3524
www.usaid.gov