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LEUCAENA: A POTENTIAL FORAGE CROP FOR THE GAMBIA

by

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Technical Report No. 7

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MIXED FARMING AND RESOURCE MANAGEMENT PROJECT
TECHNICAL REPORT NO. 7

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Introduction

Leucaena, the common name for Leucaena leucocephala (Lam.) de Wit has become one of the most popular useful trees in the tropics, being utilized for feed, wood, soil improvement and erosion control, reforestation, shade and nurse plants, green mulch and food. In some countries, especially in the humid zones, Leucaena is used in all of the above ways; in other areas, its use is more specific. In The Gambia, research on utilization of Leucaena is in its infancy but it seems probable that it will be best utilized in alley cropping, in living fences and in fodder banks as a high protein dry season livestock feed. It may also become an important source of firewood in this country. This paper will describe Leucaena, its uses and potential, the Gambian experience of Leucaena as a forage crop and areas of further research.

The Leucaena Plant

Taxonomy and Description

The genus Leucaena is classified taxonomically as belonging to the family Mimosaceae of the order Leguminales. Leucaena plants are mostly small arboreal forms or shrubs with different branching types. The branches are generally smooth, brown or gray, although in some species, very young shoots remain red during active growth. The leaves are bipinnate (see Figure 1).

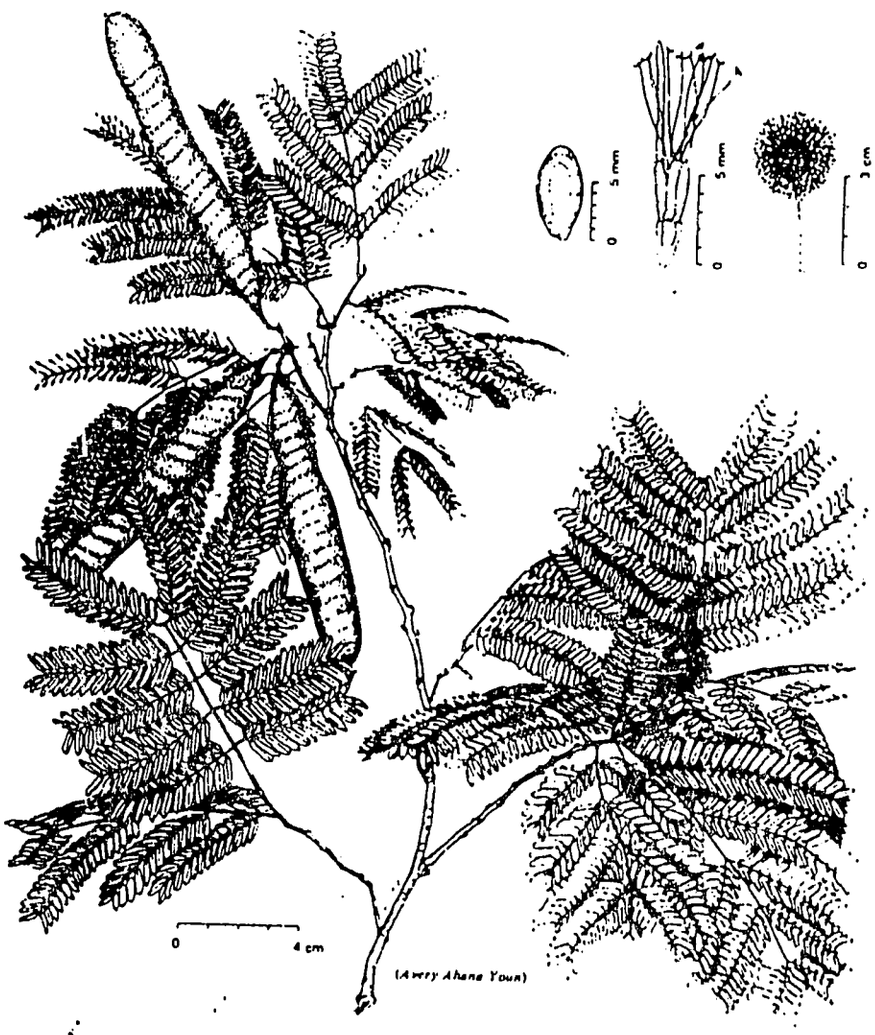

Figure 1. Leucaena (taken from NAS, 1984).

The number of paired pinna and size of the paired leaflets which compose the pinnae are widely variable among different species. Most plants have glands along the petiole, the shape and number of which vary greatly. Flowers are mostly white in dense spherical heads consisting of many individual florets. From these heads a variable number of pods emerge, in some plants as high as 20 pods in a single head. The pods are dark brown and shiny at maturity. When dry, the pods do not separate from the valves but open along the margins to shed the seed. Seeds are flat and ovate, generally brown with a darker contour along the margins. The seed varies in mature size with species. The root system is characteristically a tap root which penetrates deeply into the soil. Rhizobia are easily observed on the roots (see Figure 2).

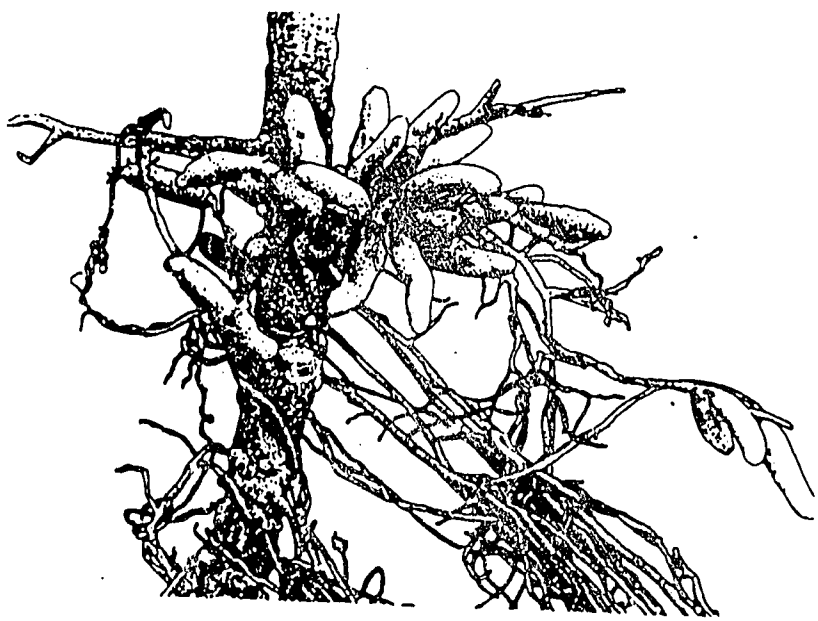

Figure 2. Rhizobia nodules on Leucaena (taken from NAS, 1984).

There are ten recognized species in the genus. L. leucocephala has intermediate size leaflets and can be a very tall tree (over 15 m). Within the species L. leucocephala are three types grouped according to maturity, vegatative vigor and yield. The Hawaiian type is relatively short and bushy, low yielding and early flowering; the Salvador type is tall, late flowering, high yielding and sparingly branched at the base; and the Peru type is tall, late flowering and strongly branched at the base. The Hawaii, Salvador and Peru types, in this order, show increasing vigor and decreasing earliness of maturity.

The plant is an evergreen, although it may lose or shed its leave during high winds or under extreme drought conditions. Leucaena is fairly drought tolerant, growing best where annual rainfall is 1000-3000 mm but has been

observed growing in areas receiving 250 mm rainfall annually. Its drought tolerance is attributed to its deep extensive root system and the xerophytic movement of its leaves (Oakes, 1968). The upward movement of the leaflets during periods of maximum sunlight reduces transpiration, which aids the plant in drought tolerance.

Reports on Leucaena's rhizobia requirements vary from very specific to non-specific. There is no doubt that the plant does better if inoculated. Often, though, the presence of other leguminous trees in the area is enough to ensure that a usable form of rhizobia is already in the soil. Poor or slow establishment of Leucaena is most often caused not by lack of proper rhizobia but by its hard-seededness. Seed viability ranges from 8-85% for untreated seed (Oakes, 1968). Scarification is necessary for best results. Methods of scarification include hot water, acid, mechanical (sandpaper or nicking) and having the seeds pass through the digestive tract of livestock. Germination occurs within one day for scarified seeds. Direct seeding, either by hand or by machine, is the cheapest and easiest method of establishment.

Leucaena seedlings are not aggressive and can be smothered by fast-growing weeds (N.A.S., 1984) which can cause total failure of the planting. The seedlings are extremely palatable to rodents and insects in the first few weeks of growth.

Uses and Potential

The center of origin for Leucaena is Central America, most probably in southern Mexico. Its use in pre-Columbian times was primarily as firewood and feed for animals; these uses continue to the present. The genus is increasingly used for erosion control and reforestation due to its rapid growth and extensive tap root system. Leucaena is also used in many parts of the world as a shade and companion (or nurse) crop in plantations of coffee, tea, cocoa, cinchona, citrus, teak, rubber, coconut and oil palm. The branches can be pruned to control the amount of sunlight. The fall of the leaves provides nitrogen-rich fertilizer to the soil. Often entire branches are cut and incorporated into the soil as a green manure especially in alley cropping systems. Nitrogen from solid leucaena stands can exceed 550 kg/ha/year (Brewbaker, 1976) which is equivalent to 2.5 metric tons of ammonium sulfate fertilizer. In some areas of central America and Southeast Asia, Leucaena is used as human food, both the leaves and seeds being eaten. The seeds can be made into a fermented paste (tempe) similar to tofu made from soybeans (Wirjodarmodjo and Wiroatmodjo, 1983). Other uses include jewelery, dyes, windbreaks and as ornamentals.

Still, Leucaena is perhaps best known now for its use as animal feed. It has often been compared to alfalfa [*Medicago sativa*] in terms of composition and they are indeed similar as shown in Table 1.

Table 1. Comparative composition of Leucaena and Alfalfa leaf meal

Component	Leucaena	Alfalfa
Total ash (%)	11.00	16.60
Total N (%)	4.20	4.30
Crude protein (%)	25.90	26.90
Modified ADF (%)	20.40	21.70
Calcium (%)	2.36	3.15
Phosphorus (%)	0.23	0.36
B-carotene (mg/kg)	536.00	253.00
Gross energy (kj/g)	20.10	18.50
Tannin (mg/g)	10.15	0.13

Source: NAS, 1977.

Leucaena has unusually high contents of B-carotene and for this reason has attracted interest as a potential poultry supplement. As for all non-ruminant animals, leucaena should not be used as a major portion of the diet. For poultry 4-6% dry weight is adequate to promote egg hatchability and to deepen the yellow of the egg yolks and skin (NAS, 1984).

Although Leucaena is highly digestable, voluntary feed intake can be low. It is best fed in conjunction with other roughages. Used as a supplement to grazing, Leucaena has been as effective as groundnut cake (Thomas and Addy, 1977). Leucaena planted between rows of grasses such as Panicium maximum has been used as main or supplemental pasture for beef and milk production for several years (Jones, 1979).

One factor that has curtailed widespread use of Leucaena as an animal feed in some areas of the world is the presence of a toxic factor in the plants. Toxicity is attributed to the amino acid mimosine which occurs in concentrations ranging from 1 to 12 percent of the dry weight depending on species, tissue type and environmental conditions (Jones, 1979). Toxic effects include hair loss, delayed sexual maturity and abnormal fetal development especially in non-ruminants. Most of the world's ruminants are able to thrive on diets of 100% leucaena (NAS, 1984). This is because their rumens contain microbes that can break the mimosene into non-toxic

compounds. It is only in Australia and a few other countries that the ruminants do not have these microbes (NAS, 1984). Plant breeding using naturally low-mimosine types, such as the Australian cultivar 'Cunningham', has produced Leucaena lines ranging from 3-5% mimisine.

Physical factors limiting the spread of Leucaena from its center of origin in Central America are mainly altitude, rainfall and soil type. Wild stands of Leucaena are found in the tropics and sub-tropics at altitudes that range from sea level to 700m; planted Leucaena can be found up to 1500m (Oakes, 1968). Leucaena is drought resistant and will survive in environments receiving from 500-400 mm annual rainfall (Oakes, 1968; Jones, 1979). Yields are closely related to the amount of water available. Forage dry matter yields of 20 tons/ha (Australia) and 6-9 tons/ha (Haiwaii) are in contrast to 3-5 tons/ha in drier regions (Brewbaker, 1976; Oakes, 1968). Leucaena requires well-drained soils and generally is not able to tolerate flooding for long periods of time. It is well-adapted to a wide variety of soils except extremely arid soils with low base status (Jones, 1979).

Leucaena in The Gambia

Introduction Trials

Although there are records of Laucaena plantings made in the 1970's, only the excellent stand planted at YBK is still productive. This stand has been cut three times in the past ten years (S. Deffendol, personal communication) and has been a source of seed and soil (for inoculum) for additional plantings.

The Forage Agronomy Unit of the Mixed Farming Project started work on Leucaena in 1982. Seed was obtained from several sources : CIAT, Australia, the Phillipines and YBK. Three sites representing three major soil associations in The Gambia were selected for the introduction trials. These were Yundum, Sapu and YBK. The amount of seed was very small (300 gm) and production was only fair, especially at Yundum. Nevertheless, enough seed was collected to expand the areas planted in 1983. In addition, plantings were made at five Mixed Farming Centers (Fatoto, Jabanack, Jenoi, Kwinella and Yallal), at the Rural Development Training Center at Mansakonko and at the village of Boiram. Full-time field crews were assigned to the Yundum, Sapu and YBK sites to care for the plots while the other sites had minimal attention given to them.

Results of the plantings at Yundum, Sapu and YBK can be found in Hedrick and Bojang's report (1983). To summarize, stands and yields were more uniform at YBK than at Sapu and Yundum. This observation suggested use of the soil from the YBK plots to inoculate Leucaena plantings at other sites and, indeed, this appeared to improve the establishment and growth of the plants, especially at Yundum.

Records have been kept on the Leucaena plantings since 1982. A summary of the results as of late 1985 is in Table 2.

Table 2. Leucaena at Yundum, Sapu and YBK

Type	Yundum		Sapu		YBK	
	Plant ht.	Maturity	Plant ht.	Maturity	Plant ht.	Maturity
Le-Phillipines	2.0	late	2.5	late	3.0	late
Le-Peru	-	-	1.8	medium	2.5	medium
Le-Australia	2.1	early	2.0	early	2.1	early
Le-Cu	2.0	medium	2.9	medium	-	-
Le-local	-	-	2.4	early	2.1	early

Despite having the same dominant soil types as YBK (Charmen and Fafuloto), the plots of Yundum are still the poorest of the three sites. Rainfall patterns (see Table 2) do not give any indication for the poorer growth at Yundum.

Table 3. Rainfall data for 1981 - 1985 (mm)

	Yundum	Sapu	Georgetown*	Bansang*
1981	682	645	706	852
1982	848	650	653	710
1983	424	553	438	459
1984	666	604	678	566

Source: Department of Water Resources, Ministry of Water Resources and Environment.

* Rainfall records are not kept at YBK.

Examination of plant roots shows that all plants are nodulating. Perhaps there is a micronutrient deficiency which cannot be detected by the soil analysis available here. Soil samples were tested for selenium at the University of Florida (Selenium being related to the content of mimosine in the plant) and the selenium levels fall within the normal range of .1 - .2 ppm.

The plantings of Leucaena and other legumes at the Mixed Farming Centers and other locations have been far less successful. As noted earlier, Leucaena seedlings are not vigorous and do require weeding during the first few months of establishment. Lack of labor and/or grazing by ruminants and rodents prevented establishment of Leucaena at all sites except Kwinella MFC.

Grazing trials

Essential to any program of forage introduction and testing is evaluation by animal performance. In 1983 large plots (20x25 m) of legumes including Leucaena, were established at Yundum, Sapu and YBK for grazing studies. Grazing studies were conducted for six months in 1984 (February and August through December) using work oxen, sheep and goats. Except for sporadic grazing of young seedlings at Sapu in September by goats, Leucaena was rarely consumed by the livestock. However, in March 1985 when all of the plots were cleared by mob grazing, Leucaenas were the first to be defoliated.

Experimental trials

In The Gambia, as in other areas of Africa, crop-livestock farmers often do not have the land nor the labor to devote to pasture production. Two major alternatives (with variations) have been tried by researchers: fodder banks and intercropping with cereal crops. Fodder banks require some sort of fencing and assurance that the land will remain under the farmer's control for at least two to four years. Neither is available in The Gambia. Furthermore, most legumes require weeding during the first few months after seeding just when all of the food crops require weeding. For these reasons, emphasis in the past two years at the research sites has been on legume and cereal intercropping.

In 1984, a large experiment was planted using three varieties of Leucaena intercropped with maize. The Leucaena seed was scarified, inoculated and planted when the maize was planted. The seedlings failed due to weed competition and were replanted at the second weeding. These seedlings also failed due to shading from the maize plants.

Accordingly, two different approaches were taken in 1985. The introduction plots established at Yundum, Sapu and YBK in 1982 and 1983 were cut off at 1m heights and were interplanted with maize. The Leucaena plants were 1m apart and the maize was planted between the rows. Rapid regrowth of the Leucaena shaded out the maize plants and the maize failed.

The second approach was to start Leucaena in plastic bags three months before the rainy season in order to have strong enough plants to compete with both weeds and the cereal crop. Three legumes-Leucaena, Gliricidia and Sesbania - were planted 4m apart and interplanted with 4 rows of maize at Yundum. Only Leucaena was planted as a seedling, the rest were planted from seed. A few weeks after planting an invasion of caterpillars (Amsacta) sp.) destroyed all of the young plants except Leucaena.

Several lessons have been learned from these experiments.

1. Leucaena is better able to withstand weed competition, insect attack, moisture stress and shading when planted as a 2-3 month old seedling.

2. When interplanting a cereal into a well-established Leucaena field, the Leucaena should be cut low (25-50cm) and recut as necessary throughout the growing season. Distance between rows of Leucaena should be 2-4m.

3. Scarification and inoculation are of lesser importance than weed control in establishing Leucaena.

Seed production

A major factor limiting forage legume production in the tropics aside from land and labor problems is the cost of the seed. Only Australia, Brazil, Colombia and the United States have been able to maintain profitable forage legume seed production. Other countries and companies can produce the seed but the profit margin is so low or non-existant that they do not do so on any great scale. In order to start any kind of forage legume program, be it fodder banks, intercrops, fence rows, pastures or whatever, it is necessary to have a readily available inexpensive source of seed. This is where Leucaena has an overwhelming advantage under Gambian conditions.

Leucaena is a prolific seeder. Flowers are formed late in the rainy season and pods begin filling in November and December. Harvesting can be done throughout the dry season but best yields are obtained in January. A 10 x 15 m plot can produce from 25-50 kg of cleaned seed. The seeds are easily separated from the pod by placing the pods in a bag and beating it with a stick. The seeds are very hard, impervious to insect attack but should be protected from rodents.

Future research and recommendations

Intercropping (or alley cropping) of Leucaena with cereal crops will continue in 1986 with the expectation of going to on-farm trials in 1987. The use of Leucaena as a fence row crop, especially around village garden plots, should be explored once establishment methods are throughly worked out. At some point feeding trials should be conducted to obtain necessary information particularly on B-carotene and Vitamin A supplement in poultry diets.

The multifarious uses of Leucaena besides as a forage crop in The Gambia have not been mentioned. The Forestry Department is doing some work on Leucaena for village wood lots; the Forage Agronomy Unit supplies them with

50-100 kg of seed every year. Such cooperation should be encouraged.

There have been problems learning how to produce Leucaena in this country. Its potential is still unproven yet if only because of its prodigious seed productivity as compared with other adopted forage legumes, work on the crop should be continued.

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