# Appendix 9

**FINAL REPORT**

***Leucaena* Evaluation Trials: Mexico, Central and South America**

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**Submitted by:** Pedro J. Argel
Trial Coordinator CIAT/OFI

## 1. Introduction

Beginning in 1996 CIAT agree to collaborate with OFI to evaluate new species of *Leucaena* in Mexico, Central and South America. The experimental seed, the inoculum, the evaluation methodology and funds to operate the network were provided by OFI. A total of 18 species of *Leucaena* were delivered to collaborators in 8 different countries; the activities were coordinated from a regional office of CIAT located in San José, Costa Rica.

All potential collaborators received the seed, however a few trials failed to establish, others were lost in the process, and others did not report back the results. In this Final Report, results from 5 countries are presented.

## 2. Seed delivered and characteristics of the evaluation sites

Packages of seed samples were mailed after contacting potential collaborators in Brazil, Venezuela, Colombia, Panamá, Costa Rica, Nicaragua, Honduras and Mexico. Table 1 gives names and institutions of *Leucaena* seed recipients and the status of the trials up to date. Most of the trials still continue under evaluation with the exception of one trial planted in Atenas, Costa Rica (subhumid tropics); in this country a new trial has been recently planted in Santa Clara (very humid tropics).

The collaborators listed all acknowledged receiving the seeds; however, not all of them had success planting the trials, and some of them were lost due to uncontrolled circumstances. Poor germination of some lines, fire and grazing by stride animals, was argumented as the main causes of trial failures. In all the cases, additional seed was dispatched when requested.

Considerable variation in soil, altitude and climate characteristics was recorded in sites where the trials established successfully. Table 2 shows variations in altitude over sea level from 33 m up to 580 m, and main ecosystems ranging from tropical dry forest, tropical isohypertermic savannas and very humid and subhumid tropical forest.

Annual total rainfall varied from 875 mm in Comayagua (Honduras) up to 4500 mm in Gualaca (Panamá), and also varied the distribution of the rains. For instance, Atenas in Costa Rica, Comayagua and Isla in Mexico have a dry period of approximately 6 months, while this period in Gualaca (Panamá) lasts from 3 to 4 months. On the other hand, mean daily temperature varied from 20.0 ºC to 26.0 ºC across sites.

Variations also existed in soil type, soil pH, percentage of soil aluminum saturation and P content. Gualaca in Panamá had the more acidic soil recorded, this site had high aluminum content and very low levels of P as well. Meanwhile, Comayagua, Atenas and Santa Clara in Costa Rica presented soils with low acidity, no problems with aluminum toxicity and medium levels of P content.

**Table 1.** Country, name of collaborator and status of *Leucaena* evaluation trials

| Country | Name and Institution | Site | Status of the Trial |
|---|---|---|---|
| Mexico | Ing. Javier Fco Henríquez<br>INIFAP | Isla, Ver. | Under evaluation<br>Reported |
| Mexico | Dr. Luis Ramírez Avilés<br>Univ. of Yucatán | Mérida, Yuc. | Lost<br>Not reported |
| Mexico | Dr. Horacio Villalón M.<br>Univ. Autónoma N. León | Linares, N. L. | Failed to establish |
| Mexico | Mr. Jacobo Minutii Z.<br>Ins. Tec. Monterrey | Cuernavaca | Lost contact |
| Mexico | Ing. Ivonne Carmona<br>INIFAP | Tapachula | Not reported |
| Honduras | Ing. Conrado Burgos<br>DICTA | Comayagua | Under evaluation<br>Reported |
| Honduras | Dr. Raúl Santillán<br>E. A. El Zamorano | Zamorano | Not reported |
| Nicaragua | Mr. Pascal Elegeert<br>FAO-PNDR-Holanda | León | Lost |
| Costa Rica | Ing. Milton Villarreal<br>Inst. Tec. of Costa Rica | San Carlos | Under evaluation<br>Reported |
| Costa Rica | Dr. Pedro J. Argel<br>CIAT- Costa Rica | Atenas | Terminated<br>Reported |
| Panamá | Ing. Gregorio González<br>U. of Panamá | Azuero | Not reported |
| Panamá | Ing. Bolívar Pinzón<br>IDIAP | Gualaca | Under evaluation<br>Reported |
| Colombia | Dr. Silvio Guzmán<br>CORPOICA | Corozal | Lost |
| Colombia | Ing. Justo Barros<br>CORPOICA | Motilonia | Under evaluation<br>Not reported |
| Venezuela | Dr. Tyrone Clavero<br>Univ. of Zulia | Maracaibo | Not reported |
| Venezuela | Dr. Jesús Faría Mármol<br>FONAIAP | Maracaibo | Not reported |
| Brazil | Mr. Moacir J. Sales and<br>Mr. Joao A. Pereira<br>EMBRAPA – FLORESTAS | Morretes, Par. | Under evaluation<br>Reported |

**Table 2**. Soil and climatic characteristics of evaluation sites new of *Leucaena* species in Mexico, Central and South America.

| Country | Site | Altitude (masl) | Predominant Ecosystem | Rainfall (mm/yr) | Mean Temp. (°C) | Soil | | | | Lat. | Long. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Type | pH ($H_2O$) | Al Sat (%) | P (ppm) | | |
| Panamá | Gualaca | 33 | TRF* | 4500 | 25.5 | Inceptisol | 4.7 | 21.5 | 3.5 | 8°30'N | 82º10'W |
| México | Isla | 50 | TSWDi | 1000 | 25.7 | Ultisol | 4.8 | Tr | 13.5 | 18°06'N | 95°32'W |
| Honduras | Comayagua | 580 | TDF | 880 | 24.7 | Chromustel | 6.5 | Tr | 6.0 | 14°21'N | 87°21'W |
| Costa Rica | San Carlos | 225 | TRF | 3430 | 26.0 | na | 5.9 | 1.5 | 6.0 | 10°21'N | 84°29'W |
| | Atenas | 460 | STF | 1600 | 23.7 | Inceptisol | 5.9 | Tr | 3.6 | 9°58'N | 84°23'W |
| Brazil | Morretes | 59 | LMTF | 1890 | 20.6 | na | 3.5 ($CaCl_3$) | 78.0 | 2.0 | 25°28'S | 49°50'W |

*TRF = Tropical rainforest; TSWDi = Tropical savanna well drained isohypertermic; TDF = tropical dry forest; STF = Subhumid tropical forest; LMTF= Low mantane tropical forest.

## 3. Results

Results are presented for each individual country, and acknowledgments are included for the technitians and institutions that participated in the evaluation of the trials. The trial under the responsability of CIAT and planted in Atenas, Costa Rica, is presently the only trial terminated, and despite that other trials are still under evaluation, some general conclusions can be made related to plant adaptation, plant productivity and tolerance to the psyllid insect.

A general evaluation methodology produced by OFI was handed over to collaborators together with the seed samples; plot size and number of plants per plot were similar in all the experiments, but the initiation of the uniformity cut and frequency of evaluation cuts differed from site to site. Collaborators adjusted the evaluation systems to their particular local conditions.

### 3.1 Costa Rica

Measurements of plant height, regrowth height, stem diameter, foliar retention, plant mortality, psyllid damage and dry matter yields of edible and not edible tissues were taking for a period of two years in Atenas; preliminary results have been published by Argel and Pérez (1997, 1998).

Considerable variation in growth, plant mortality at the end of the second dry season, regrowth capacity following cutting, psyllid tolerance and dry matter yields, were observed between *Leucaena* species. Plant height 10 months after planting varied from 0.5 m to more than 1.5 m; the best initial growth was recorded in *L. collinsii* subsp. *collinsii* 52/88, and the poorest growth was observed in *L. multicapitula* 81/87.

Table 3 shows good regrowth capacity following cutting, both for the wet and dry season , of *L. leucocephala* subsp. *glabarata* 34/92 (K 636, cv. Tarramba in Australia), *L. collinsii* 52/88 and *L. macrophylla* subsp. *nelsonii* 47/85, and very poor regrowth of *L. pulverulenta* 83/87, *L. esculenta* subsp. *esculenta* 47/87, *L. trichodes* 61/88 and *L. multicapitula* 81/87. Other *Leucaena* species had intermediate regrowth capacity.

*C. argentea* CIAT 18668 (a different genus), produced even better regrowth during the dry period indicating the good growth of the plant at this time of the year, while *C. callothyrsus* DPI 115690 did not have adaptation to the site.

Plant mortality at the end of the second dry season was high for *L. multicapitula* 81/87, *L. trichodes* 61/88 and *L. lempirana* 6/91. No mortality was recorded for cv. Tarramba, *L. macrophylla* subsp. *nelsonii* 47/85, *Leucaena* hybrids 52/87 and 1/95, *L. salvadorensis* 17/86, *L. pallida* 14/96, *L. diversifolia* subsp. *diversifolia* 83/92, *L. collinsii* subsp. *zacapana* 56/88 and *L. esculenta* subsp. *esculenta* 47/87. Other *Leucaena* species had plant mortality that ranged from 1 to 4 plants.

Psyllid damage was scored at monthly intervals on a nine point scale (1 = no damage; 2 = young leaves moderately curled; 3 = tips and young leaves curled and yellow; 4 = tips and young leaves severely curled, yellow and covered with sap; 5 = lost of up to 25 % of young leaves; 6 = lost of up 50 % of young leaves; 7 = lost of up to 75 % of young leaves; 8 = lost of up to 100 % of young leaves and darkening of older leaves, and 9 = stained stems and total lost of foliage).

The psyllid insect was present throughout the trial but it did not cause plant mortality, although differences existed between *Leucaena* species related to psyllid tolerance. The highest damage index rated was 4.0 and observed in *L. salvadorensis* 17/86, *L. collinsii* subsp. *zacapana* 56/88 and *L. multicapitula* 81/87. *L. trichandra* 53/88, showed good tolerance, while other promissing materials like cv. Tarramba and *L. collinsii* 52/88 had ratings of 3.4 and 2.0 respectively.

Mild attacks of the fungus *Camptomeris leucaenae* were recorded, particularly in old leaves of *Leucaena* species.

**Table 3.** Height of regrowth, plant mortality and psyllid damage of *Leucaena* species and one line each of *Cratylia argentea* and *Calliandra callothyrsus* established in Atenas, Costa Rica (Means of 4 cuts every 8 weeks during the wet season and 4 cuts every 8-12 weeks during the dry season).

| Species | ID No. (OFI) | Regrowth height (cm) Wet | Regrowth height (cm) Dry | Plant mortality (No.)** | Psyllid damage |
|---|---|---|---|---|---|
| *L. leucocephala* subsp. *glabrata* | 34/92 | 139.4 a * | 97.7 ab | 0 | 3.4 |
| *L. collinsii* | 52/88 | 117.6 ab | 81.2 bc | 1 | 2.0 |
| *L. macrophylla* subsp. *nelsonii* | 47/85 | 111.8 bc | 100.9 a | 0 | |
| *Leucaena* hybrid (unknown parents) | 52/87 | 101.0 bcd | 59.2 de | 0 | 2.0 |
| *L. salvadorensis* | 17/86 | 97.4 bcde | 66.7 cde | 0 | 4.0 |
| *L. trichandra* | 53/88 | 95.6 bcde | 69.1 cde | 4 | 1.2 |
| *L. pallida* | 14/96 | 91.7 bcdef | 59.2 de | 0 | 1.2 |
| *L. diversifolia* subsp. *diversifolia* | 83/92 | 90.9 cdef | 69.9 cde | 0 | 1.5 |
| *L. lempirana* | 6/91 | 88.4 cdef | 65.5 cde | 8 | 3.8 |
| *L. leucocephala x L. pallida* (F5) | 1/95 | 87.8 cdef | 71.4 cde | 0 | 2.5 |
| *L. shannonii* subsp. *magnifica* | 19/84 | 87.7 cdef | 76.6 cd | 3 | 3.0 |
| *L. collinsii* subsp. *zacapana* | 56/88 | 81.2 def | 54.5 e | 0 | 4.0 |
| *L. lanceolata* | 43/85 | 76.2 def | 61.3 cde | 2 | 3.0 |
| *L. pallida* | 79/92 | 73.4 ef | 36.2 f | 2 | 1.3 |
| *L. leucocephala* CIAT | 17263 | 72.1 ef | 71.3 cde | 1 | 2.5 |
| *L. pulverulenta* | 83/87 | 41.7 g | 29.2 f | 3 | 2.0 |
| *L. esculenta* subsp. *esculenta* | 47/87 | 40.9 g | 28.2 f | 0 | 1.0 |
| *L. trichodes* | 61/88 | 16.1 g | 7.8 g | 11 | 3.5 |
| *L. multicapitula* | 81/87 | 4.1 i | 1.8 g | 22 | 4.0 |
| *C. argentea* CIAT | 18668 | 67. 3 f | 69.9 cde | 0 | 1.0 |
| *C. callothyrsus* DPI | 115690 | 4.1 i | 0.0 | 22 | 1.0 |

*
Within a column means followed by the same letter are not significatly different (P>0.05)
** Plant mortality at the end of the second dry season

Dry matter yields of edible tissues were close to 100 g/plant/cut during the wet season for the following species: *L. trichandra* 53/88, *L. collinsii* 52/88, cv. Tarramba, *L. pallida* 14/96 and *Leucaena* hybrids 1/95 and 52/87 (Table 4). These lines also produced high DM yields during the dry period with the excepsion of *Leucaena* hybrid 52/87 that had a reduction of nearly 50% yield during this period. It was also interesting to note that *L. macrophylla* subsp. *nelsonii* 47/85 (also a promissing line) had a tendency to produce more DM yield during the dry period, and indication of tolerance to prolonged dry seasons.

Meanwhile, very low DM yields during the same period (less than 50 g/plant/cut) were recorded for *L. lempirana* 6/91, *L. shannonii* subsp. *magnifica* 19/84, *L. trichodes* 61/88 and *L. multicapitula* 81/87. Other *Leucaena* species had intermediate DM yields.

**Table 4.** Edible dry matter (DM) yields of *Leucaena* species and one line each of *Cratylia argentea* and *Calliandra collothyrsus* established in Atenas, Costa Rica (Means of 4 cuts every 8 weeks during the wet season and 4 cuts every 8 – 12 weeks during the dry season).

| Species | ID No. (OFI) | Edible DM yields (g/plant) | | Edible/Total (g/plant) | |
|---|---|---|---|---|---|
| | | Wet | Dry | | |
| *L. trichandra* | 53/88 | 118.8 | 96.2 | 215.0 | a* |
| *L. collinsii* | 52/88 | 110.5 | 100.4 | 210.9 | a |
| *L. leucocephala* subsp. *glabrata* | 34/92 | 104.2 | 85.1 | 189.3 | ab |
| *L. pallida* | 14/96 | 104.1 | 65.7 | 169.8 | bc |
| *Leucaena hybrid* (unknown parents) | 1/95 | 98.7 | 70.1 | 168.7 | bc |
| *L. macrophylla* subsp. *nelsonii* | 47/85 | 79.0 | 81.8 | 160.8 | bcd |
| *L. leucocephala* CIAT | 17263 | 82.0 | 73.4 | 155.4 | bcd |
| *L. leucocephala* x *L. pallida* ($F_5$) | 52/87 | 102.9 | 49.9 | 152.8 | bcd |
| *L. salvadorensis* | 17/86 | 81.7 | 70.4 | 152.1 | bcd |
| *L. lanceolata* | 43/85 | 75.1 | 60.1 | 135.2 | cde |
| *L. diversifolia* subsp. *diversifolia* | 83/92 | 74.0 | 59.7 | 133.6 | def |
| *L. pallida* | 79/92 | 81.7 | 44.5 | 126.2 | defg |
| *L. esculenta* subsp. *esculenta* | 47/87 | 87.2 | 38.2 | 125.4 | efg |
| *L. pulverulenta* | 83/87 | 64.7 | 42.0 | 106.7 | efg |
| *L. collinsii* subsp. *zacapana* | 56/88 | 57.9 | 38.4 | 96.3 | fg |
| *L. lempirana* | 6/91 | 45.4 | 47.9 | 93.4 | fg |
| *L. shannonii* subsp. *magnifica* | 19/84 | 40.5 | 47.1 | 87.7 | g |
| *L. trichodes* | 61/88 | 11.2 | 4.1 | 15.3 | h |
| *L. multicapitula* | 81/87 | 3.6 | 1.7 | 5.3 | h |
| *C. argentea* CIAT | 18668 | 110.4 | 102.6 | 212.9 | a |
| *C. callothyrsus* DPI | 115690 | 21.5 | 15.5 | 40.0 | h |

* Within a column means followed by the same letter are not significantly different P>0.05)

### 3.2 Brazil

In Morretes, Paraná, we had the only trial located in the southern hemisphere. Temperature had a mean of 20.6 ºC, and the soils have high aluminum concentration and low levels of P (Table 2). The trial is still under evaluation.

Plant height and edible DM yiels are presented in Table 5. It is clear that *L. trichandra* 53/88 has been the species with better adaptation to the site producing more than double of DM yield than the next best *Leucaena* (*L. diversifolia* subsp. *diversifolia* 83/92). *L. pallida* 14/96, *L. lempirana* 6/91 (a species of poor adaptation in Cota Rica) and *L. macrophylla* subsp. *nelsonii 47/85*, have also showed good adaptation to the site. Meanwhile, cv. Tarramba has adapted poorly, as well as *L. trichodes* 61/88 and *L. collinsii* 52/88 (a species of good adaptation in Costa Rica).
The presence of the psyllid insect in this site has not been observed.

**Table 5**. Plan height and dry matter yields of *Leucaena* species established in Morretes, Paraná, Brazil (Means of one cut 335 days after planted)(Information supplied by Moacir J. Sales Medrado and Joao A. Pereira Fowler of EMBRAPA-FLORESTAS).

| Species | ID No. (OFI) | Plant height (cm) | DM yields (g/plant) | |
|---|---|---|---|---|
| | | | Edible | Total |
| *L. trichandra* | 53/88 | 236.7 | 284.4 | 407.4 |
| *L. diversifolia* subsp. *diversifolia* | 83/92 | 203.3 | 82.2 | 128.7 |
| *L. pallida* | 14/96 | 183.3 | 75.3 | 118.8 |
| *L. lempirana* | 6/91 | 166.7 | 51.7 | 95.0 |
| *L. macrophylla* subsp. *nelsonii* | 47/85 | 190.0 | 49.4 | 79.1 |
| *L. lanceolata* | 43/85 | 116.7 | 47.3 | 62.4 |
| *L. salvadorensis* | 17/86 | 183.3 | 34.0 | 61.4 |
| *L. multicapitula* | 81/87 | 153.3 | 19.4 | 38.4 |
| *L. leucocephala* subsp. *glabrata* | 34/92 | 130.0 | 14.4 | 33.1 |
| *L. collinsii* subsp. *zacapana* | 56/88 | 146.7 | 16.4 | 31.3 |
| *L. trichodes* | 61/88 | 150.0 | 15.3 | 27.1 |
| *L. collinsii* | 52/88 | 123.3 | 12.2 | 25.7 |
| *L. esculenta* subsp. *esculenta* | 47/87 | 93.3 | 2.1 | 8.9 |

### 3.3 Panamá

The site in Gualaca has a very acidic soil (pH 4.7) and more than 1 ppm of aluminum concentration (Table 2). Although the total rainfall is high (4500 mm), the site has 4 months of severe dry period from december to april. These conditions have affected the growth of *Leucaena* species and edible DM yields are lower compared to other sites for the same period of growth (Table 6). However, significant differences have been recorded between *Leucaena* lines; cv. Tarramba, *L. pallida* 14/96, *L. macrophylla* subsp. *nelsonii* 47/85 and *L. lanceolata* 43/85 have shown better growth up to date; these lines also have a better leaf retention during the dry period.

*L. trichandra* 53/88 had intermediate DM yields, while *L. collinsii* 52/88, of poor performance also in Brazil, has shown poor adaptation as well; also *L. trichodes* 61/88 and *L. collinsii* subsp. *zacapana* 56/88.

Most of the *Leucaena* species had an strong apical dominance as growth habit, and no damage has been recorded caused by the psyllid insect. This trial will continue for another growing season.

**Table 6.** Plant height, diameter, dry matter yields and growth habit of Leucaena species planted in Gualaca, Panamá (Means of one cut 90 days after planting) (Information supplied by Boliviar Pinzón of IDIAP).

| Species | ID No. (OFI) | Plant Height (cm) | Stem diameter (mm) | Growth habit | Edible DM yields (g/plant) |
|---|---|---|---|---|---|
| *L. leucocephala* subsp. *glabrata* | 34/92 | 120 | 11.2 | 1 | 50 |
| *L. pallida* | 14/96 | 94 | 11.7 | 4 | 41 |
| *L. macrophylla* subsp. *nelsonii* | 47/85 | 130 | 14.6 | 1 | 40 |
| *L. lanceolata* | 43/85 | 102 | 10.8 | 2 | 38 |
| *L. leucocephala* x *L. pallida* ($F_5$) | 52/87 | 112 | 12.4 | 2 | 37 |
| *L. trichandra* | 53/88 | 95 | 11.0 | 5 | 34 |
| *L. shannonii* subsp. *magnifica* | 19/84 | 122 | 12.2 | 1 | 31 |
| *L. multicapitula* | 81/87 | 114 | 11.8 | 3 | 26 |
| *L. lempirana* | 6/91 | 126 | 9.3 | 1 | 24 |
| *L. diversifolia* subsp. *diversifolia* | 83/92 | 89 | 11.1 | 4 | 21 |
| *L. esculenta* subsp. *esculenta* | 47/87 | 49 | 4.7 | 1 | 16 |
| *L. trichodes* | 61/88 | 121 | 6.3 | 1 | 16 |
| *L. collinsii* | 52/88 | 72 | 7.3 | 2 | 12 |
| *L. collinsii* subsp. *zacapana* | 56/88 | 110 | 9.8 | 4 | 12 |

### 3.4 Mexico

Isla in Veracruz, has a dry savanna type of environment; the soils are acidic (pH 4.8) but with only traces of aluminum and aceptable levels of P (Table 2). This site has a dry period of 6 months from november to may, and generally from may to july strong wet wins are common which are locally named as ‘nortes’.

Table 7 shows that a local check of *L. leucocephala* and similar introductions fron CIAT as well as cv. Tarramba, have had a clear tendency of better adaptation to this particular environment than other *Leucaena* species. The accession *L. leucocephala* CIAT 17263 showed good adaptation to Atenas, Costa Rica in an experiemnt carried out in 1991-1992, but more recently it has been overyielded by new species of *Leucaena* (see Table 4). Other species that are worthed to be mentioned because good adaptation to this site are *L. pallida* 14/96, *L. trichandra* 53/88 and *L. lanceolata* 43/85, but poor adaptation showed *L. collinsii* 52/88 (one of the best in Costa Rica) and *L. trichodes* 61/88 that seems to have poor adaptation to all the sites described so far.

This trial will continue for another growing season. No psyllid damage has been reported up to date.

**Table 7.** Regrowth height and dry matter yields of *Leucaena* species and one line of *Cratylia argentea* established in Isla, Veracruz, Mexico (Means of 3 cuts every 8 weeks during the wet period) (Information supplied by Javier Francisco Enriquez of INIFAP)

| Species | | ID No. (OFI) | Plant height (cm) | DM yields (g/plant) |
|---|---|---|---|---|
| *L. leucocephala* | CIAT | 17263 | 140 | 326.3 |
| *L. leucocephala* | CIAT | 9904 | 140 | 333.7 |
| *L. leucocephala* (local check) | | | 130 | 321.7 |
| *L. leucocephala* | CIAT | 774 | 140 | 321.0 |
| *L. leucocephala* subsp. *glabrata* | | 34/92 | 150 | 287.3 |
| *L. pallida* | | 14/96 | 110 | 207.7 |
| *L. trichandra* | | 53/88 | 90 | 143.0 |
| *L. lanceolata* | | 43/85 | 90 | 106.0 |
| *L. esculenta* subsp. *esculenta* | | 47/87 | 70 | 98.3 |
| *L. macrophylla* subsp. *nelsonii* | | 47/85 | 90 | 83.3 |
| *L. collinsii* | | 52/88 | 90 | 66.0 |
| *L. trichodes* | | 61/88 | 60 | 52.3 |
| *C. argentea* | CIAT | 18957 | 60 | 86.0 |

### 3.5 Honduras

Comayagua has a subtropical dry environment with only 875 mm of total rainfall per year, distributed from April to October (Table 2). The soils are of medium fertility with only traces of aluminum and pH of 6.5. These acceptable soil and climatic characteristics are responsible for the high edible DM yields reported in Table 8 for cv. Tarramba, *L. pallida* 14/96, *L. leucocephala* CIAT 17263, *L. collinsii* 52/88 and *L. pulverulenta* 83/87. *L. trichandra* 53/88 had intermediate yields, while *L. multicapitula* 81/87, *L. diversifolia* subsp. *diversifolia* 83/92, *L. collinsii* subsp. *zacapana* 56/88, *L. shannonii* subsp. *magnifica* 19/84 and *L. lempirana* 6/91, have shown poor adaptation to this particular site.

At this site a forage quality analysis of the *Leucaena* species was carried out. It is interesting to note that some of the more promissing materials accross sites have crude protein values over 20.0 % ( *L. pallida* 14/96, *L. leucocephala* CIAT 17263, *L. collinsii* 52/88 and *L. macrophylla* subsp. *nelsonii* 47/85). Meanwhile in this test *L. pulverulenta* 83/87, *L. collinsii* subsp. *zacapana* 56/88 and *L. lempirana* 6/91 had relatively low protein content.

This trial will continue under evaluation for another growing season. The psyllid insect has been reported only as present, but with no damage to the plants.

**Table 8.** Dry matter yields and crude protein of *Leucaena* and other species planted in Comayagua, Honduras(Means of 3 cuts during the wet season) (Information supplied by Conrado Burgos of DICTA).

| Species | ID No. (OFI) | Dry matter yields (g/plant) Total | Dry matter yields (g/plant) Edible | Protein (%) |
|---|---|---|---|---|
| *L. leucocephala* subsp. *glabrata* | 34/92 | 672.1 | 426.4 | 17.8 |
| *L. pallida* | 14/96 | 523.9 | 354.0 | 20.6 |
| *L. leucocephala* CIAT | 17263 | 459.0 | 329.4 | 16.1 |
| *L. collinsii* | 52/88 | 290.8 | 208.9 | 23.7 |
| *L. pulverulenta* | 83/87 | 246.7 | 195.5 | 13.5 |
| *L. leucocephala* x *L. pallida* ($F_5$) | 52/87 | 255.9 | 157.5 | 16.3 |
| *L. esculenta* subsp. *esculenta* | 47/87 | 203.6 | 154.5 | 17.1 |
| *L. macrophylla* subsp. *nelsonii* | 47/85 | 244.5 | 148.9 | 22.6 |
| *L. lanceolata* | 43/85 | 201.3 | 132.6 | 17.0 |
| *L. trichandra* | 53/88 | 155.9 | 116.0 | 19.1 |
| *L. trichodes* | 61/88 | 104.5 | 67.7 | 19.6 |
| *L. multicapitula* | 81/87 | 87.3 | 67.6 | 19.3 |
| *L. diversifolia* subsp. *diversifolia* | 83/92 | 64.2 | 45.9 | 11.0 |
| *L. collinsii* subsp. *zacapana* | 56/88 | 52.2 | 41.5 | 15.1 |
| *L. shannonii* subsp. *magnifica* | 19/84 | 47.7 | 29.0 | 17.4 |
| *L. lempirana* | 6/91 | 38.3 | 28.7 | 9.8 |
| *C. argentea* CIAT | 18668 | 173.3 | 139.6 | 17.3 |
| *G. sepium* (local check) | | 151.8 | 119.8 | 14.4 |

### 3.6 Other sites

#### 3.6.1 Costa Rica

A new trial to evaluate the adaptation of new species of *Leucaena* has been planted in Santa Clara, Alajuela, Costa Rica, in collaboration with the Instituto Tecnológico de Costa Rica (ITCR). The site has the following charateristics: Very humid tropical rainforest, 172 masl, 3100 mm of annual rainfall and 26 ºC mean temperature, located at 10 º 22' lat. N and 85 º 31' long. W. The soils are caly-loam ultisols (Typic haplohumult), with pH 6.0 ($H_2O_2$), 3.0 ppm of P and respectively 5.3, 2.7, 0.2 and 1.3 meq/100 g of Ca, Mg, Al and K.

A total of 16 *Leucaena* species have been planted following the methodology suggested by OFI. Replanting was done and the trial is ready for evaluation (Information supplied by Ing. Milton Villarreal from ITCR).

### 3.6.2 Colombia

New species of *Leucaena* were planted during 1997/98 in Motilonia, Cesar, Colombia, in collaboration with the Corporación Colombiana de Investigación Agropecuaria (CORPOICA). The site has the following characteristics: Dry tropical forest with the following soil characteristics: pH 6.2 ($H_2O_2$), 1.0 % organic matter, 72.0 ppm of P and respectively 2.0, 0.3, 0.05 and 0.6 meq/100 g of Ca, Mg, K and Na.

A total of 17 *Leucaena* species are planted following the metodology proposed by OFI. The trial is under evaluation but data is not presented; however in a field visit made last year to this trial the following species were showing good growth: *L. macrophylla* subsp. *nelsonii* 47/85, cv. Tarramba and *L. lanceolata* 43/85. This year the trial was replanted and the plot population of all the species has improved (Information supplied by Ing. Justo Barros from CORPOICA).

## 4. Complementary activities to the trials

The new *Leucaena* species under evaluation in Atenas (Costa Rica) and in Comayagua (Honduras), have been components in field day demostrations to farmers and students as well; it is likely that the trials planted in Mexico and Brazil have been used for the same purpose. The most interesting observations made are related with the variability of plant morphology observed for the different species of *Leucaena.* Most people when thinking on *Leucaena*, have a predefined picture only of *L. leucocephala* species, and experiencing other lines like *L. macrophylla*, *L. trichodes* or *L. lanceolata*, which have lager leaflets, is very educational and make people aware of the variability within the genus.

Preliminary results from the trial carried out in Atenas, have been publisbed as follows:

Argel, P. J. and Pérez, G. 1997. LEUCNET Leucaena trials in Mexico, Central and South America, and early results from Costa Rica. LEUCNET News, No. 4 July 1997, 13–14.

Argel, P. J. and Pérez, G. 1998. Adaptation of new species of *Leucaena* in Costa Rica, Central America – Preliminary results. In: Shelton, H.M., Gutteridge, R.C., Mullen, B.F. and Bray, R.A. (eds). Leucaena- Adaptation, Quality and Farming Systems. ACIAR Proceedings No. 86, Camberra, Australia. p 146 –149.

At the XLV Regional Meeting of the PCCMCA held in Guatemala city this year (April 1999), the following paper was presented by Ing. Conrado Burgos: Evaluación Agronómica Preliminar de 16 Ecotipos de *Leucaena* en la Región Centro Occidental de Honduras.

## 5. General comments

The *Leucaena* trials were pretended to be evaluated under an uniform methodology proposed by OFI, related to plot size, number of plant per plot, cutting height, psyllid rating and frequency of evaluation. However, local circumstances obliged collaborators to adapt the evaluation of the trials to their own circumstances, particularly in relation with initiation and frequency of the evaluation cuts. Most of the trials had to be replanted because of failures in germination of some of the lines, and this produced some changes in the management of the trials, but in espite of that, useful conclusions can be made retaled to the adaptation of new *Leucaena* species to different environments in the Latin American tropics.

The species *L. trichandra* 53/88, *L. leucocephala* subsp. *glabrata* 34/92 (cv. Tarramba in Australia), *L. pallida* 14/96 and *L. macrophylla* subsp. *nelsonii* 47/85, showed good adaptation across sites. *L. collinsii* 52/88 also performed well in Honduras and Costa Rica (subhumid tropics with medium fertility soils), but poorly in Brazil, Panamá and Mexico; this corresponds with information that indicates that the latter species grows naturally in dry and semi-arid environments of Mexico and Guatemala (Hughes, 1998). The resistance to the psyllid insect of this species and the good protein content reported from Honduras (23.7 %), suggests good forage potential of the species for dry environments.

*L. trichandra* has considerable variability within the species, and the resistance to the psyllid insect, to poor acid soils and the forrage quality, are directly related to plant origin. The present line evaluated, *L. trichandra* 53/88, originates from Los Guates (Guatemala), and is regarded as more tolerant to the psyllid insect and of superior growth than other plants from different origins in Mexico and Centralamerica (Hughes, 1998).

*L. pallida* is highly resistant to the psyllid insect and has been an important source of resistance in plant breeding programs of *Leucaena*. The present line evaluated, *L. pallida* 14/96, is a composite coming from CSIRO (Australia); it showed aceptable DM yields across sites and good level of crude protein (20.6 %); for this reasons it should be considered a species that has also good forage potential.

*L. macrophylla* is a less known species, and one the characteristics of this plant is the larger size of the leaflets (3 –7 cm long). These trials showed that the species has a wide range of adaptation and grows well in subhumid as well as in humid environments with very acid soils like in Gualaca, Panamá. It had 22.6 % of crude prtein as reported from Comayagua, Honduras, indicating that it is a species worthed to be consider for further evaluation.

Cultivar Tarramba is presently used widely in Australia in cattle farms. It is susceptible to psyllid and has much of the forage quality characteristics of other *L. leucocephala* species. It showed good agronomic performance across sites and it is a germplasm readily available for commercial planting, since seed is available in Australia.

These trials also showed the poor adaptation to all sites of *L. trichodes* 61/88 (a species originated in Jipijapa, Ecuador), and also poor were *L. lempirana* 6/91 and *L. multicapiula* 81/87.

The psyllid insect did not caused serious problems to new *Leucaena* species at any site, perhaps because the insect has natural enemies in this part of the world. Close observation of the insect was followed in Atenas, Costa Rica, but the foliar damage recorded did no represent significant lost of DM yields.

As a general conclusion, the terminated and still under evaluation trials of the new species of *Leucaena*, allowed the identification of potentially more productive species than the traditional *L. leucocephala* species. It is necesary to follow up the best lines and concentrate in other agronomic aspects such as seed production potential, forage and wood quality and seedling vigour, to fully appreciate the oportunities that these new lines may have in different production systems.

## 6. Future perspectives of the *Leucaena* genus in the region

There are well known inherent factors to the species *L. leucocephala* that limit its adoption, such as: poor cold tolerance, heavy defoliation during prolonged dry periods, poor growth on acid soils, heavy pod production, low wood durability, susceptibility to a defoliating psyllid and too slow to establish. However, there are also well known benefits that this tree legume produces in different farming systems, particularly in cattle farms because its high quality forage.

Although, there have been detailed discussions before on the poor adoption of *Leucaena* species in the Latin American tropics (Argel *et al.*, 1998), there are three main points that I consider have a major relevance for the future of the *Leucaena* in the region:

1. The need to improve on-farm demostrations on the utilisation of *Leucaena*
2. The need to educate farmers on the benefits of using *Leucaena* in different farming systems, and
3. The need to solve the problems of establishment, particularly those related with weed control during the first stages of plant growth

The promissing new species of *Leucaena* presented in this report, have the potential to become part of the production systems of the region, but more agronomic and utilisation studies are needed, and more important, any use of any of the species has to be faced bearing in mind the three points mentioned before, otherwise these important plants may not reached farmers as we may expect and wish.

## 7. References

Argel, P.J., Lascano, C.E. and Ramírez, L. 1998. *Leucaena* in Latin American Farming Systems: Chalenges for Development. In: Shelton, H.M., Gutteridge, R.C., Mullen, B.F. and Bray, R.A. (eds). Leucaena-Adaptation, Quality and Farming Systems. ACIAR Proceedings No. 86, Camberra, Australia. p. 319-323.

Hughes, C.E. 1998. *Leucaena*: Manual de Recursos Genéticos. Oxford Forestry Institute, University of Oxford. Tropical Forestry Papers No. 37, 280 p.