

## ILC2018 Keynote Paper\*

# Leucaena feeding systems in India

## Sistemas de alimentación con leucaena en la India

NANDINI NIMBKAR

Nimbkar Agricultural Research Institute (NARI), Phaltan, Maharashtra, India. [nariphaltan.org](http://nariphaltan.org)

### Abstract

Since its introduction to India in 1976 *Leucaena leucocephala* ssp. *glabrata* has spread rapidly, especially in the last couple of decades, mainly due to its use as either firewood or pulpwood. Use of its foliage for feeding livestock has been mainly a by-product of this activity. The foliage is highly nutritious because it has high protein concentration and good palatability, and the tree can withstand repeated defoliation. Research carried out by Indian scientists on leucaena has focused on mainly agronomic management, agroforestry studies of mixed cropping systems, mimosine toxicity, germplasm testing and economic evaluation. Feeding leucaena has had a positive impact on the dairy industry in particular. It is rarely purchased for fodder and is usually poached by smallholders from existing plantations, most of which are established by animal rearers for their own purposes. More widespread use of leucaena for fodder could be achieved in India by introducing varieties with either reduced seed production or sterile ones, which can be easily propagated vegetatively. In addition, psyllid resistance, suitable mechanized harvesting methods and training livestock owners in proper management of leucaena trees should help in making this high quality fodder more popular in India.

**Keywords:** Fuelwood, leguminous tree fodders, pulpwood, silvopastoral systems.

### Resumen

Desde su introducción a la India en 1976, *Leucaena leucocephala* ssp. *glabrata* se ha dispersado rápidamente, especialmente en las últimas dos décadas, sobre todo debido a su uso como leña o pulpa para papel. El uso de su follaje para la alimentación de ganado ha sido más bien un subproducto de esta actividad. El follaje es de alto valor nutritivo debido a su alta concentración de proteína y buena palatabilidad; a su vez esta especie arbustiva puede soportar defoliaciones frecuentes. Investigaciones llevadas a cabo en la India se han centrado en el manejo agronómico, estudios agroforestales en sistemas de cultivos mixtos, toxicidad de mimosina, evaluación de germoplasma y análisis económicos. La alimentación de ganado con leucaena ha tenido un impacto positivo sobre todo en la producción de leche. La leucaena es rara vez comprada para la utilización como forraje; generalmente los productores extraen su follaje de plantaciones existentes que en su mayoría son establecidas por criadores de ganado para sus propios fines. Un mayor uso de leucaena como forraje en la India se puede lograr mediante la introducción de variedades con escasa producción de semillas o hasta estériles, que se puedan propagar fácilmente en forma vegetativa. Además, variedades resistentes a los psílidos, métodos de cosecha mecanizada adecuados y capacitación de los propietarios de ganado en el manejo adecuado de los árboles de leucaena deberían contribuir a que este forraje de alta calidad se vuelva más popular en la India.

**Palabras clave:** Árboles forrajeros leguminosos, leña, pulpa para papel, sistemas silvopastoriles.

### Introduction

*Leucaena leucocephala* ssp. *leucocephala* (shrubby 'common' type) is supposed to have been introduced into

India from Mexico more than a century ago as a fast-growing species for afforestation. It spread rapidly into various habitats ([Ghate 1991](#)) and became naturalized. After Dr J.L. Brewbaker (University of Hawaii) supplied

Correspondence: Nandini Nimbkar, Nimbkar Agricultural Research Institute (NARI), Tambmal, Phaltan-Lonand Road, P.O. Box 44, Phaltan – 415523, Maharashtra, India. Email: [nimbkar@gmail.com](mailto:nimbkar@gmail.com)

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seeds of *L. leucocephala* ssp. *glabrata* (arboreal 'Hawaiian giant' or 'Salvador' type) in 1976, the popularity of leucaena rapidly increased, mainly through the efforts of the Bharatiya Agro Industries Foundation (BAIF), Pune.

Leucaena leaf and small stems are a nutritious feed for all kinds of animals because they contain high protein concentration and are highly palatable, while the plants can withstand repeated defoliation.

The semi-arid climate in many parts of India and the pressure on land use have increased the importance of tree and shrub fodders as components of feeds for ruminants compared with grasses or grass-herbaceous legume pastures. Many fodder trees are not cultivated and the landless population, which owns small herds of sheep and goats, depends on accessing shrubs and tree feed resources growing near the villages, on roadsides and community lands (Raghavan 1990). Although most trees and shrubs used for animal feed are self-sown, in some traditional farming systems in India, trees are planted with crops to provide sources of fuel and feed (Chen et al. 1991). Therefore, though the arboreal type of leucaena is a relatively new introduction to India, the farming system in which it is used is generally a traditional one.

## Research and development

Five areas of research have been the focus of concerted efforts by Indian scientists: agronomic management to optimize sustained yields; agroforestry studies of mixed cropping systems; mimosine toxicity; germplasm testing; and economic evaluation (Hegde and Gupta 1994).

Some of the more extensive data on the effects of varietal or spacing differences on forage yields of leucaena in India are from BAIF Research Development Foundation (Relwani et al. 1983). The Indian Grassland and Fodder Research Institute (IGFRI) at Jhansi conducted a series of leucaena alley farming trials with crops such as maize, sorghum, buffel grass, millet and napier grass with generally beneficial outcomes (Gill et al. 1982, 1983; Gill and Patil 1983, 1984, 1985).

From a survey of leucaena toxicity status based on assays of urinary DHP excretions, it was concluded that India is one of the 8 countries protected from toxicity by the presence of *Synergistes jonesii* (Jones 1994). However, more recently Pattanaik et al. (2007) reported that mimosine was rapidly converted to 3,4-dihydroxypyridine (3,4-DHP) post-ingestion resulting in poor animal performance on otherwise high-quality pasture. While mimosine toxicity can be potentially severe, it is relatively short-term and is manifest only when animals are first introduced to high leucaena diets.

Their rumen microflora have an ability to fully degrade mimosine in high (>50%) leucaena diets within 2 weeks from initial introduction (Ghosh et al. 2007).

## Adoption

Adoption of improved pasture systems such as those with leucaena is very low owing to limited land availability, low producer confidence, establishment issues and costs and psyllid attack on existing varieties.

The pattern of adoption of leucaena in the M. Nidamanuru village of Andhra Pradesh state (Saigal and Kashyap 2002) is representative of the situation in most parts of India. The farmer who originally brought leucaena to the area placed advertisements in the local papers and sold seeds from his plantations to farmers. Over the next few years, leucaena planting spread rapidly in the village and in 2000, most farmers had some part of their land planted to leucaena. Timber from stems was initially sold as firewood for tobacco curing barns but subsequently the pulpwood market developed and farmers began growing leucaena to sell to the pulpwood industry. Leucaena plantations had a positive impact on the dairy industry with village milk production increasing from 50–60 L/day to 900–1,000 L/day, due to the increased availability of nutritious fodder in the form of leucaena leaf. Fat content of the milk also reportedly increased. Landless and marginal farmers were apparently the main beneficiaries, as expenditure on buying fodder from the market was reduced by more than a third. Leucaena foliage was obviously poached from the plantations and not purchased from their owners. While damage caused to the plantations through lopping and grazing was significant, surprisingly, according to the authors of the report, plantation owners did not perceive this as a major problem and most did not object to it. In the experimental plantations of cvv. Tarramba and Wondergraze on Nimbkar Agricultural Research Institute (NARI) lands leafy branches are also often seen broken and taken away by the surrounding livestock owners.

To illustrate adoption by a specific farmer, an interview was conducted with Mr Vikram Dattatray Yadav on 16 May 2018 (Figures 1–3). His farm is located at Yadav Wasti, Kala Odha, Shiravli, Tal. Baramati. He had planted 0.4 ha of leucaena in 2016 using seed of variety K8 bought from BAIF for INR 225/kg (1 USD = 68 INR). He planted rows 120 cm apart with 30 cm spacing within rows, and supplied drip irrigation every 4 days. He fertilizes with goat manure and cuts 4 times per year. Rogor (dimethoate 30 EC at 30 mL/15 L water) or Nuvan (dichlorvos 76 EC at 40 mL/15 L water) is sprayed for psyllid control during winter.



**Figure 1.** Mr Yadav's leucaena plantation.



**Figure 2.** Re-sprouting leucaena in Mr Yadav's plantation.



**Figure 3.** Mr Yadav's goats feeding on leucaena.

Mr Yadav has 74 Osmanabadi goats that he feeds either leucaena or lucerne twice a day – the amount offered is not weighed. While he observed that his goats gained weight at a relatively faster rate when fed leucaena

than any other fodder, his fodder supply from the 0.4 ha was insufficient for the 74 goats year-round. There is currently no ready market for the wood produced.

### Profitability

Under rainfed conditions, leucaena variety K636 (marketed in Australia as cv. Tarramba), either as a pure stand or in intercropping systems, recorded higher gross and net returns than arable cropping in Andhra Pradesh ([Prasad et al. 2011](#)). The main product was wood for industrial use.

At our institute (NARI), in 5 plantations with a total area of 3.5 ha, we have planted cvv. Wondergraze and Tarramba, which we intend to use for fodder and seed production, at a density of 2,644 plants/ha. During the first year, estimated fresh edible biomass production from cutting every 4 months was about 4,000 kg/ha per harvest. The expenditure including establishment and cutting costs came to INR 30,000/ha/yr, giving a cost of about INR 2.50/kg fresh edible biomass produced. Therefore the sale price of fresh fodder should be at least INR 3/kg. Since leucaena fodder can be easily harvested from naturalized areas at no cost, there is a limited market for the sale of leucaena forage. However, the main problem was that there were no buyers for the wood of small size (3–5 cm diameter), as in the last 2–3 years, availability of liquid petroleum gas for cooking, even in rural areas, has increased tremendously. Such a venture has a chance of becoming profitable only if the wood can be used for industrial purposes such as production of paper pulp.

### Future relevance

Some of the main reasons why leucaena was shunned by many farmers in India were its prolific seeding and resultant weediness. Moreover, being an aggressive species it was seen to adversely affect the growth of other species in agroforestry systems. Varieties such as K8 were also very susceptible to the psyllid pest (*Heteropsylla cubana*), which is especially damaging during the coldest 4 months (winter). While the trees do recover and there is rarely any mortality, growth and fodder yield suffer. In spite of high protein deficits in ruminant nutrition, leucaena is still underutilized in states like Kerala, owing to limited land availability for planting, low biomass yields and difficulty in harvesting ([Raj et al. 2016](#)).

To overcome the problems of weediness and psyllids, the outstanding hybrid KX2 shows promise as it is psyllid-resistant as well as practically seedless. However, since its saplings have to be produced by vegetative



propagation, supplying the quantity of planting material desired by farmers at an affordable price has proved difficult. The new variety, cv. Redlands, recently released in Australia, may offer a partial solution, as it is psyllid-resistant and easy to propagate from seed, although the weediness potential remains. However, under a pasture-based model, ease of propagation from seed is definitely a major advantage for any fodder species.

Many farmers contacted by us reported 'difficulty in harvesting' as the main reason for leucaena not being used as widely as it should. They need to be made aware of planting patterns whereby double-row hedges of leucaena can be formed, which can be trimmed every 3–4 months by cutting at 1 m height from the ground. Depending on the spacing between the hedges, grasses such as buffel (*Cenchrus ciliaris*) or *Chrysopogon fulvus* can be planted once leucaena is established. Mechanized harvesting using small tractor-mounted machines may be another solution to the problem.

Companies like J.K. Paper Ltd. have established clonal seed orchards by first identifying Candidate Plus Trees from the existing plantations and then rooting the coppiced cuttings from these trees in mist chambers. The saplings so developed are either utilized for setting up clonal seed orchards or establishing mother plants in raised beds filled with sand as a source of juvenile coppice cuttings for mass production. Thus farmers are supplied with either seeds or rooted cuttings. Similarly, leucaena clones have also been developed by ITC Limited with their current planting level of about 3,000 ha/year (Kulkarni 2013 pers. comm.).

## Conclusions

At present, large-scale plantations of leucaena like those in Queensland, Australia are rarely seen in India, but leucaena is quite commonly utilized as a fodder by livestock farmers. The source is leucaena trees from industrial plantations (such as for paper pulp), roadside trees and trees on field boundaries.

Availability of psyllid-tolerant cultivars which are sterile or seedless, but can be easily and cheaply propagated via cuttings, will go a long way in popularizing leucaena fodder in India. Small tractor-mounted or stand-alone harvesting machines, if available, should lead to more widespread use of this highly palatable, high-protein feed in India.

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## References

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- Chen CP; Halim RA; Chin FY. 1992. Fodder trees and fodder shrubs in range and farming systems of the Asian and Pacific region. In: Speedy A; Pugliese P-L, eds. Legume trees and other fodder trees as protein source for livestock. Proceedings of the FAO Expert Consultation, Kuala Lumpur, Malaysia, 14–18 October 1991. p. 11–22. [bit.ly/31xNZpK](http://bit.ly/31xNZpK)
- Ghate VS. 1991. Noteworthy plant invasions in the flora of Western Ghats of Maharashtra. Journal of the Bombay Natural History Society 88:390–394. [biostor.org/reference/152965](http://biostor.org/reference/152965)
- Ghosh MK; Atreja PP; Buragohain R; Bandyopadhyay S. 2007. Influence of short-term *Leucaena leucocephala* feeding on milk yield and its composition, thyroid hormones, enzyme activity, and secretion of mimosine and its metabolites in milk of cattle. The Journal of Agricultural Science 145:407–414. doi: [10.1017/S0021859607007113](https://doi.org/10.1017/S0021859607007113)
- Gill AS; Patil BD. 1983. Mixed cropping studies in leucaena under intensive forage production system. Leucaena Research Reports 4:20.
- Gill AS; Patil BD; Yadav CL. 1982. Intercropping studies in leucaena. Leucaena Research Reports 3:30.
- Gill AS; Patil BD; Yadav CL. 1983. Intercropping studies in hybrid napier varieties associating leucaena and other leguminous fodder shrubs. Leucaena Research Reports 4:21.
- Gill AS; Patil BD. 1984. Crop association studies in leucaena under rainfed conditions. Leucaena Research Reports 5:24–25.
- Gill AS; Patil BD. 1985. Intercropping studies with leucaena under an intensive fodder production programme. Leucaena Research Reports 6:36–37.
- Hegde NG; Gupta VK. 1994. Leucaena in India. In: Shelton HM; Piggins CM; Brewbaker JL, eds. Leucaena – opportunities and limitations. Proceedings of a workshop held in Bogor, Indonesia, 24–29 January 1994. ACIAR Proceedings No. 57. ACIAR, Canberra, ACT, Australia. p. 182–185. [bit.ly/2UphJVM](http://bit.ly/2UphJVM)
- Jones RJ. 1994. Management of anti-nutritive factors with special reference to leucaena. In: Gutteridge RC; Shelton HM, eds. Forage tree legumes in tropical agriculture. CAB International, Wallingford, UK. p. 216–231.
- Pattanaik AK; Khan SA; Goswami TK. 2007. Influence of iodine on nutritional, metabolic and immunological response of goats fed *Leucaena leucocephala* leaf meal diet. The Journal of Agricultural Science 145:395–405. doi: [10.1017/S0021859607007058](https://doi.org/10.1017/S0021859607007058)
- Prasad JVNS; Korwar GR; Rao KV; Srinivas K; Srinivasarao C; Pedababu B; Venkateswarlu B; Rao SN; Kulkarni HD. 2011. On-farm evaluation of two fast growing trees for biomass production for industrial use in Andhra Pradesh, Southern India. New Forests 42:51–61. doi: [10.1007/s11056-010-9236-6](https://doi.org/10.1007/s11056-010-9236-6)
- Raghavan GV. 1990. Availability and use of shrubs and tree fodder in India. In: Devendra C, ed. 1990. Shrubs and tree

- fodders for farm animals. Proceedings of a workshop, Denpasar, Indonesia, 24–29 July 1989. p. 196–210. [hdl.handle.net/10625/20020](https://hdl.handle.net/10625/20020)
- Raj RM; Raj AK; Kunhamu TK; Jammaludheen V; Prakash A. 2016. Fodder yield and nutritive value of subabul (*Leucaena leucocephala* Lam.) under diverse management regimes in coconut garden. Indian Journal of Agroforestry 18:79–85. [bit.ly/2KG7ZQa](https://bit.ly/2KG7ZQa)
- Relwani LL; Mohatkar LC; Bhavsar GK; Nakat RV. 1983. Effect of spacings and stubble heights on forage yields of K-8 and Cunningham. *Leucaena Research Reports* 4:41.
- Saigal S; Kashyap D. 2002. The second green revolution: Analysis of farm forestry experience in Western Terai region of Uttar Pradesh and coastal Andhra Pradesh. Ecotech Services Private Limited, New Delhi, India. [pubs.iied.org/pdfs/9185IIED.pdf](https://pubs.iied.org/pdfs/9185IIED.pdf)

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