

## ASSESSMENT OF SEVERAL FUELWOOD CUM FODDER SPECIES TRIALS IN PAKISTAN

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### Abstract

A comparison of height-growth data of 40 fuelwood/fodder species was made under eight barani and irrigated conditions in Pakistan. The results revealed that the *Eucalyptus camaldulensis* provenance originating from Australian Northern Territory of Alice Springs, *E. microtheca* and AY-48 clone of *Populus deltoides* gave the best growth. For fodder, *Acacia nilotica*, *Albizia procera*, *Leucaena leucocephala* and *Robinia pseudoacacia* were rated best. Steps to bring about further genetic improvement in these species are discussed.

### Introduction

Lying between 24°-37°N latitude and 61°-75°E longitude, Pakistan is a unique combination of deserts, alluvial plains, low and high hills of the Himalayan region. A high proportion of geoclimatic diversity has made it a land of many contrasts. In the south, for example, the summer temperature may touch 48°C while in the north, the mercury goes upto zero and even below in winters. The rainfall pattern also shows a wide amplitude from 100-1500 mm per annum.

With such a varied type of climatic pattern, out of 87.98 million ha. of total land area of Pakistan; 20.58 million ha. area is cultivable and 8.88 million ha. is culturable waste. Both these areas are suitable for growing trees. Forest covers an area of 4.28 million ha. which is around 4.8% of the total land surface. Out of total forest cover approximately 63 % is state owned which is under the administrative control of Provincial Forest Departments (Forestry Sector Master Plan, 1992 and Amjad *et al.*, 1996). The primary reason for such a meager forest cover is that about 70-80% of the area is arid and semi-arid where precipitation is not only low but highly erratic which can not support any extensive tree cover. The soil otherwise is generally fertile and rich in nutrients. The state land mainly consists of natural range lands, forests and irrigated plantations. The reserve and privately owned coniferous forests are found in wet and dry temperate areas as

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well as in the sub-tropical parts of northern and north-eastern parts of Pakistan. There is severe shortage of timber, fuelwood and fodder throughout the country. Few fuelwood and fodder tree species, growing naturally in the high hill tracts, are: *Aesculus indica*, several coniferous and *Quercus* spp; etc. Due to acute fuel shortage in these areas, people even use pines and other valuable conifers like deodar (*Cedrus deodara*) etc for burning. At lower altitudes, main fuelwood and fodder species are: *Acacias*, *Dalbergia sissoo*, *Eucalyptus*, *Melia azedarach*, *Morus alba*, *Prosopis* spp. and *Tamarix* spp. etc. Generally these are also planted by the farmers on their farmlands to meet their domestic requirements. The demand of fuelwood and fodder in the high hill forests and plantations is increasing speedily due to population pressure and increase in livestock number. These problems can be reduced if suitable taxa are encouraged specially in midlands of Pakistan. It would be thus desirable to assess the growth (height) of fuelwood/fodder species trials established in the past in different ecological zones of Pakistan to mitigate the demand of local inhabitants.

The paper highlights the results of eight trials established since mid 70,s in different ecogeographical zones of Pakistan. A few fuelwood and fodder species were found suitable over different sites with respect to their height and diameter growth. Depending upon the silvicultural requirements, the foresters should promote these promising species. The pressure on the natural forests will greatly reduce if these fast growing species are used for planting on farmlands as well as used in afforestation programmes in Pakistan.

## Materials and Methods

Both exotic and indigenous species were assessed for their potential as fuelwood cum fodder at the following 8 sites in Pakistan. Out of these, the first 6 locations were non-irrigated while last 2 sites were irrigated. The height-growth data at various ages were recorded from a statistically well designed experiments. The geographic location of these test sites is given in table 1.

With varying number of species from site to site, the list of 40 species includes: *Acacia aneura*, *A. modesta*, *A. nilotica*, *Ailanthus altissima*, *Albizia lebbek*, *A. procera*, *Amorpha fruticosa*, *Bauhinia variegata*, *Bombax ceiba*, *Casuarina equisetifolia*, *C. glauca*, *C. montana*, *C. suberosa*, *Ceratonia siliqua*, *Celtis australis*, *Conocarpus lancifolius*, *Dalbergia sissoo*, *Eucalyptus camaldulensis*, *E. globulus*, *E. tereticornis*, *E. torelliana*, *E. microtheca*, *E. melanophloia*, *E. rudis*, *Fraxinus xanthoxyloides*, *Gleditsia triacanthos*,

*Hardwickia binata*, *Leucaena leucocephala* and its 2 varieties viz. K-8 and K-67, *Melia azedarach*, *Morus alba*, *Pinus halepensis*, several clones of *Populus deltoides*, *Prosopis cineraria*, *Quercus dilatata*, *Q. incana*, *Robinia pseudoacacia*, *Sapindus mukorossi*, *Tecoma undulata*, *Ulmus wallichiana* and *Zizyphus mauritiana*. The seedlings were grown at Peshawar under uniform conditions and one-year-old plantable stock was test planted at eight sites in central and southern Pakistan at an altitude varying between 30-1300 m. Due to limited scope of coniferous species, mainly broad-leaved species were included. These trials could be divided into two irrigational regimes (a) Barani (non-irrigated) and (b) irrigated. This paper highlights achievements on the basis of height-growth data recorded during varying ages at several sites. Further details of these trials are given in the following paragraphs:

Table 1. Geographic location of 8 sites

Sites		Latitude°	Longitude°	Altitude (m)
i.	Nowshera (NWFP)	33 45	71 31	350
ii.	Jamrud (NWFP)	34 02	71 33	365
iii.	Almehra, Abbottabad (NWFP)	34 05	73 16	1300
iv.	Soor Gul, Kohat (NWFP)	33 10	70 34	400
v.	Chattar Kalas (AJ&K)	34 01	73 20	600
vi.	Speena Shaga, Kohat (NWFP)	33 11	70 33	400
vii.	Miani (Sindh)	25 23	68 25	30
viii.	Mirpur Mathelo (Sindh)	27 55	68 27	125

## Results and Discussion

### A) Barani trials:

(i) A trial of 5-species was established in March 1977 at Nowshera (NWFP) at 350 m altitude with annual rainfall of 350 mm. The species included: *Dalbergia sissoo*, *Casuarina montana*, *C. suberosa*, *C. glauca* and *Euclayptus microtheca*. The trial consisted of 4 replications in RCB design with varying number of plants in each plot. The spacing followed was 3 x 3 m. Only one post-planting watering was given. The results indicated that *E. microtheca* at age 11

had given highest diameter of 23.2 cm. Analysis of variance revealed significant differences among species ( $F=8.2^{**}$ ) and non-significant among replications.

ii) Another 7-species trial was established at Jamrud (NWFP) under similar climatic conditions in 1977. The species were: *Albizia lebbeck*, *Eucalyptus microtheca*, *E. melanophloia*, *E. tereticornis*, *Gleditsia triacanthos*, *Tecoma undulata* and *Zizyphus mauritiana*. The trial was laid out in RCB design with 4 replications and 50 tree-plot. At the time of planting, hand watering was done to individual tree spaced at 2 x 2 m apart. 4-year-growth data had indicated significant differences between species and non-significant between replications for survival, diameter and height. The survival %age ranged between 34-87 while the diameter and height ranged between 0.7-2.5 cm and between 0.5-2.2 m respectively. LSD test had shown that *E. microtheca* and *E. tereticornis* were at the top while *Zizyphus mauritiana* and *Tecoma undulata* were at the bottom.

iii) A 12-species trial consisting of *Ailanthus altissima*, *Albizia lebbeck*, *Amorpha fruticosa*, *Celtis australis*, *Eucalyptus camaldulensis*, *E. tereticornis*, *Gleditsia triacanthos*, *Melia azedarach*, *Morus alba*, *Quercus incana*, *Robinia pseudoacacia* and *Sapindus mukorossi* was conducted at Almhra, Abbottabad (1300 m) in 1986 with annual rainfall of approximately 1300 mm. The trial consisted of 4 replications with 20-tree-plot in RCB design. Survival and height-growth data indicated that *Morus alba* and *Gleditsia triacanthos* and *Amorpha fruticosa* had shown best survival. *Sapindus mukorossi* and *Albizia lebbeck* had given poor performance.

iv) A 20-species trial was established at Soor Gul (Kohat) in August, 1986 at 2 x 1 m spacing following single-tree plot design with 20 replications. The species were: *Acacia albida*, *A. modesta*, *A. senegal*, *A. victoriae*, *Amorpha fruticosa*, *Bauhinia variegata*, *Casuarina cunninghamiana*, *C. glauca*, *C. suberosa*, *Eucalyptus camaldulensis*, (local and Northern Australian sources), *E. melanophloia*, *E. rudis*, *E. tereticornis*, (local and exotic sources), *Leucaena leucocephala* (varieties  $K_8$  and  $K_{67}$ ), *Pinus halepensis* and *Prosopis cineraria*. Among all, *Leucaena leucocephala* and northern provenance of *E. camaldulensis* from Alice Springs performed best so far height growth is concerned. Comparative performance of several varieties of Ipil Ipil (*Leucaena leucocephala*) has been reported by Siddiqui *et al* (1983) and Sheikh *et al* (1989) in Pakistan.

v) A 15-broad leaved species trial was established in January, 1987 at 2.4 m espacement at Chattar Kalas (Azad Jammu & Kashmir) in 4 replications with 20 tree-plot in RCB design. The species were: *Acacia modesta*, *A. aneura*, *Ceratonia siliqua*, *Eucalyptus camaldulensis* (local and an Australian northern source), *E. torelliana*, *E. rudis*, *E. globulus*, *E. tereticornis*, *Fraxinus xanthoxylodies*, *Gleditsia triacanthos*, *Leucaena leucocephala*, *Melia azedarach*, *Robinia pseudoacacia* and *Ulmus wallichiana*. The growth varied greatly and mean values for height ranged between 20.2-65.2 cm at age 2. Best height-growth was shown by *Robinia pseudoacacia* (65.2 cm) and *E. rudis* while *Ceratonia siliqua* performed poorly (height = 20.2 cm).

vi) A 5-species trial was established at Speena Shaga (Kohat) at 400 m altitude in March 1987 which consisted of 6 replications with 20 tree-plot in RCB design at 2 x 2 m spacing. The species were *Casuarina montana*, *C. suberosa*, *C. glauca*, *Ceratonia siliqua* and *Eucalyptus camaldulensis*. One-year-old height growth data had indicated that *E. camaldulensis* and *Casuarina suberosa* showed maximum height of 1.5 m as compared to lowest value of *Ceratonia siliqua* (height 0.9 m).

## B) Irrigated trials

These trials were established in southern Pakistan at 2 sites. Seedlings were watered through flood irrigation by a tubewell as and when required because the annual precipitation of the area is 160 mm.

i) A trial of 10 species viz. *Acacia nilotica*, *Albizia procera*, *Bombax ceiba*, *Casuarina equisetifolia*, *Conocarpus lancifolius*, *Dalbergia sissoo*, *Eucalyptus camaldulensis*, *Hardwickia binata*, *Leucaena leucocephala* and *Populus deltoides* was replicated in March, 1983 at Mirpur Mathelo, Sindh. The experiment was established in RCB design with 6 replications and 60 tree-plot at 2 x 2 m spacing. The height growth data recorded at age 4 indicated that height ranged between 3.9-12.4 m and diameter between 3.8-16.6 cm. These had attained better height growth at Miani than at Mirpur Mathelo. The LSD test showed that *Acacia nilotica*, *Albizia procera*, *Eucalyptus camaldulensis* and *Populus deltoides* had better height and diameter than others. Analysis of variance gave significant differences between species and non-significant between replications for both the characters. Therefore, the aforementioned four species are highly suitable for Sindh compared with other species. Unless otherwise

recommended, species like *Casuarina equisetifolia*, *Conocarpus lancifolius* and *Hardwickia binata* may not be used for large scale plantations in Sindh because of their slow growth.

Few researchers like Burley (1980) and Palmberg (1981) have listed several species suitable for fuelwood to improve the rural living. Their suitability will, however, vary from area to area and in some cases upon seed source. The same is true for fodder species under varying ecological conditions in Pakistan. Several species are in vogue to overcome the fodder/fuelwood problems in the country but very few species are doing better under certain ecological conditions.

ii) A 10-broad leaved species trial was also established at Miani, Sindh in April 1983 over an area of 1.4 ha. The experiment was laid in RCB design with 6 replications and 60 tree-plot at 2 x 2 m spacing. The trial consisted of *Acacia nilotica*, *Albizia procera*, *Bombax ceiba*, *Casuarina equisetifolia*, *Conocarpus lancifolius*, *Dalbergia sissoo*, *Eucalyptus camaldulensis*, *Hardwickia binata*, *Leucaena leucocephala* and *Populus deltoides* (clone AY-48). Height-growth at age 4 ranged from 7.2-11.8 m and diameter from 7-15.1 cm. The LSD test showed that *E. camaldulensis* and *P. deltoides* had maximum height. The analysis of variance gave significant differences among species for height ( $F=10.8^*$ ) and diameter ( $F=5.1^*$ ) and non-significant among replications.

Based upon the data collected from these trials, promising species for lower and mid elevations in respect of fodder and fuelwood is presented in the following Table 2.

Table 2. Promising species at lower and mid elevations in Pakistan

Ecological zones	Fodder species	Fuelwood species
Lower elevations ( < 400 m)	<i>Leucaena leucocephala</i> , <i>Albizia procera</i> , <i>Acacia nilotica</i>	<i>E. microtheca</i> , <i>E. tereticornis</i> , <i>E. camaldulensis</i> , <i>Populus deltoides</i> (AY-48 clone)
Mid elevations (1200-1500 m)	<i>Morus alba</i> , <i>Robinia pseudoacacia</i>	<i>E. rudis</i> , <i>Pinus halepensis</i> , <i>Populus deltoides</i>
The following fuelwood/fodder species are not recommended for planting mainly because of their slow growth.		
Lower elevations	<i>Zizyphus mauritiana</i> , <i>Ceratonia siliqua</i>	<i>Tecoma undulata</i> , <i>Casuarina equisetifolia</i>
Mid elevations	<i>Albizia lebbeck</i>	<i>Sapindus mukorosi</i>

It is clear from the above table that few species may be given top priority in afforestation programmes in the country because of their better survival, height and diameter growth. It is further desired that Seed Production Areas of these species may be established following provenance/progeny trials to improve the fuelwood and fodder production in Pakistan. Leaf biomass of suitable fodder species may also be determined alongwith height-growth data. Following these steps, it is hoped that the pressing demand of fuelwood and fodder of the local inhabitants could be minimized to some extent in the country.

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