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Lucerne, Lablab and *Leucaena leucocephala* Forages: Production and Utilization for Livestock Production

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Abstract: An overview is given of three legume pastures with potentials as sources of crude protein and other important nutrients for livestock production in Botswana. This paper reviews distribution, plant description, agronomic characteristics, chemical composition and utilization in livestock production of Lucerne, lablab and *L. leucocephala.* Production and utilization of these 3 legumes for animal production will provide adequate nutrition and also reduce grazing pressure on natural ranges.

Key words: Lucerne, lablab *Leucaena leucocephala*, nutrition

Introduction

With increasing demand for meat and other animal protein sources, there is a need to increase productivity of each hectare of grazing land without degrading the natural resources of the country. This can be achieved by increasing production of cultivated pastures. Milk production requires a high level of nutrients and good forage should always be available. Botswana's production of silage, hay and fodder is still on a small scale and mainly done by commercial and institutional farms. In addition to cereal and grasses, legumes such as Lucerne (alfalfa), lablab purpureus and Leucaena leucocephala are now grown for fodder. Alfalfa alone or in grass mixtures of buffel grass, buffalo grass and panicum maximum are grown in the Southern Region where soil and moisture conditions permit for commercial hay production.

If forage cultivation is being introduced into an area, species suitable for the local ecological conditions and farming system have to be selected. Appropriate species can be selected only if the purpose of forage cultivation is clear, for example to increase the amount of forage available during a particular season, to increase the quality of the ration for a specific production aim, etc (Bayer and Waters – Bayer, 1998). They also stated that, the new forage plants must bring significant advantages in at least one characteristic in comparison with existing forage – husbandry practices and/or species. Tainton (2000) stated that, is important to appreciate that veld and pastures can play complementary roles in providing fodder to livestock. He suggested that before pastures are introduced into any system an assessment should be made of the extent to which productivity is likely to be increased, the amount of capital needed, the livestock system which is envisaged, the availability of labour and management expertise, and perhaps most important of all, the attitude of each individual farmer to pasture development.

Livestock production is low because of poor nutrition, which primarily is derived from natural pastures and limited amounts of crop residues (Karachi, 1997). While the production of natural pastures is low, roughages also have low nutritive value, but can be improved by supplementing them with forage legumes. Lablab combines a great number of qualities that can be used successfully under various conditions. It is adaptable to drought, is able to grow in a diverse range of environmental conditions world wide. Staying green during the dry season, it has been known to provide up to six tonnes of dry matter/ha (Murphy and Colucci, 1999).

Lucerne (*M. sativa*) is a drought ,hardy, summer growing perennial legume which provides high quality forage (Gault *et al.,* 1995). A number of studies have demonstrated that Lucerne can increase soil organic matter, improve soil structure and build up nitrogen (N) reserves in topsoil (Gault *et al*., 1995). Feeding small quantities of supplemental protein to animals grazing warm season perennial grasses has shown to increase ADG and forage intake. Although cool-season grasses usually contain more crude protein and are more digestible than warm season grasses, supplementation with energy or protein can increase dry matter intake. Instead of purchasing a protein supplement, producers may opt to use home grown forages, such as alfalfa (Lucerne) to provide supplemental protein to grazing livestock (Philips *et al.,* 2002).

Leucaena Leucocephala is the mostly widely used species as a valuable fodder shrub for increased animal production in the tropics (Khamseekhiew *et al*., 2001) .It is an ever green forage rich in protein, minerals and B carotene. The plant can also be grazed directly, is well accepted by livestock, particularly goats and is quite resistant to heavy, frequent defoliation (Meissner, 1997). In order to bridge the gap between demand and supply of high forage, *leucaena leucocephala* has been extensively propagated for eco-regeneration.

Table 1*: Different names used for *lablab purpureus*

Dolichos lablab	lablab Garbanzo	India Butter bean	Bonavista Bean
Country bean	Frijol dolichos	hyacinth bean	Tonga bean
Dolichos bean	Caballero	Egyptian bean	poor's man bean
Lablab vulgaris	Lubia bean	siem bean	Chimbolo bean
Hierba de Conejo	Frijol jacinto	Poronto japones	Gallinita

* source: Murphy and Colucci (1999)

Table 2: Subspecies of *lablab purpureus*

ssp purpureus	*ssp benhalensis*	*ssp uncinatus*
-scimatar shaped pods	linear oblong pods	wild form in tropical Africa
-cultivated as pulse crop	pulse crop of Asiatic origin	pods and seeds are similar but smaller than those of spp purpureus
-used as a commercial forage or green manure	-used in Africa as forage crop	-readily eaten by livestock

Lablab purpureus: Lablab is a vigorous twining annual or short-lived perennial sown for forage. Lablab performs well in new ground, and its large seed can be planted in a rough seed bed. It will grow on acid soils, and responds well to super phosphate. Seed is sown at 6 kg/ha in a mixture, or at 6 kg/ha in a mixture, or at 15 – 20 kg per ha as the sole legume. Lablab responds well to rotational or strip grazing, removing stock after the leaves have been eaten but before the stems have been grazed too low.

C.V. Rongai is a late – flowering variety with white flowers, Rongai seeds are light brown coloured. C.V. High worth flowers are purple, producing pods borne above the leaf canopy. High worth seed is black. Perennial lablabs are being selected for grazing and to restore soil fertility in cropping areas.

Lablab purpureus, previously classified as *Dolichos lablab*, is known in different parts of the world by different names (Table 1).

History and distribution: Lablab is thought to be indigenous to India, south east Asia or Africa. Now it has been cultivated and distributed throughout the tropics and sub tropics. It is most popular in India, south east Asia, Egypt and the Sudan (Evans, 2002). As early as 1819, seeds of lablab from Egypt were planted in the botanical gardens in Sydney, New South Wales. However it was not until after the release of the cultivar "Rongai" in 1962, that lablab became widely used as a forage in Australia. Currently lablab is one of the major leguminous forage and green manure crop (Murphy and Colucci, 1999). Lablab has been widely distributed to many tropical and subtropical countries where it has become naturalized. In South and Central America, East and West Indies, Asia, China and India lablab is a grown as an annual or short lived perennial. In these areas, the seeds and the immature seeds are used for human food while the herbage is used as green manure, for erosion control, and as a feed supplement for cattle grazing mature pasture in the dry season.

Plant description: Lablab is a climbing or erect annual or short lived perennial. It grows up to 1 meter (3.2ft) high with longer stems in climbing types (up to 6 meters or 20 ft). The leaves are pubescent, trifoliate, 1-6 in) long and 1.5-14 cm wide. Flowers are purple or white, 4-20 cm long and 1.2-1.6 cm in diameter on peduncles that are 2-40 cm long (Evans, 2002). Pods vary in shape and in colour, flat or inflated, 5. long by 1.5 cm wide. The dorsal side of the leaf is smooth with the underside being hairy (Murphy and Colucci, 1999). Of the two hundred types of lablab recognized, only two cultivars, Rongai and High worth, are available commercially (Murphy and Colucci, 1999). Additionally, three subspecies have been identified: *ssp purpureus, ssp benhalensis* and *ssp uncinatus*

Cultivars: Lablab cultivar "Rongai" was introduced from the Rongai region of Kenya to subtropical and tropical Australia (Evans, 2002). It is a white flowering, vigorous productive cultivar (Evans, 2002). Rongai is a summer growing, rampant and vigorously twinning herbaceous annual or short lived perennial. Stems trail, reaching 3 to 6 meters in length; broad ovate rhomboid leaflets acute at the apex, range between 6-7 m in length; and are arranged in a trifoliate manner. Leaves are almost glabrous on the upper surface and have short hairs on the lower surface. Petioles are long and slender and inflorescence lax, fascicled, of many flowered racemes on elongated peduncles. Pods are 4-5 cm in length containing 2-4 buff or pale brown seeds with a conspicuous white hilum. The brown, ovoid and laterally compressed seeds number 3600-4300 per Kg (Barnard, 1972). Rongai is a late maturing white flowering cultivar that will continue to grow until cut or damaged by frosts. In the absence of frost, flowering may continue for several months.

High worth cultivar: The High worth cultivar originated from Coimbatore, south India and is morphologically similar to Rongai. Contrasting with the green foliage,

Table 3: Summaries crude fibre, neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) values for the lablab plant and various fractions

Sample	Crude fibre	NDF	ADF	ADL	Reference
Whole plant		42.4	31.8	4.74	Aganga & Autlwetse, 2000
Leaf	41.8	29.6	10.8		Karachi, 1997
Stem	61.8	49.3	10.8		Karachi, 1997
Leaf		26.6			Shehu *et al*., 2001
Stem		43.6			Shehu *et al*., 2001
Lablab green forage		46.5	33.1		Jingura *et al*., 2001
Lablab hay	43				Umunna *et al*., 1995

Table4: Crude fibre, NDF, ADF and ADL values for Lucerne

Sample	Crude fibre	NDF	ADF	ADL	Reference
Pellet		24.31	14.10		Philips *et al.,* 2002
Hay	29.9				Aganga *et al*., 2000
Hay		51.1	34.9	6.5	Aganga & Monyatsiwa, 1999

Digestibility

Sample	DMD%	Reference
Untreated Lucerne (*in situ*)	71.2	Ballet *et al.,* 1997
Hay	58.6	Aganga & Monyatsiwa, 1999

white flowers and light brown seeds of Rongai, foliage of High worth has a purple band near the leaf axil, purple flowers and black seeds. High worth is an early flowering line with high seed yield ability; it is suitable for pulse production and forage uses. It was originally intended for grain production in districts where early frost prevented seeding of Rongai. It should be noted that the Rongai cultivar is the most prevalent in the tropical legume literature. The remainder of the review will deal mainly with the *lablab purpeus* cv Rongai.

Agronomic Characteristics: Lablab is a legume well suited to most tropical environments it is adaptable to a wide range of rainfall, temperature and altitude (Murphy and Colucci, 1999). It is reported to grow well under warm, humid conditions at temperatures ranging from 18-30 ^{o}C and the minimum temperature for growth is 3^{o}C. It has low frost tolerance but will survive light frosts which will damage leaves (Evans, 2002). Lablab is drought hardy, and has been grown in arid, semi-arid and humid regions with rainfalls between 750-2500mm (Evans, 2002). Once it is established, is drought tolerant (due to a deep tap root) and is reported to grow in areas with 200-2500mm rainfall / year. It does not tolerate water-logging. Being a hardy plant it can be found, throughout the tropics and subtropics; ranging from 30^{o} south to 30^{o} north latitude. It is normally grown from sea level up to elevations of between 1800 - 2100 meters.
Lablab grows well in a wide range of soil types from deep sands to heavy black clays and can tolerate pH ranges of 5-7.5 (Murphy and Colucci, 1999). PH range from 4.5-6.5. The soils should be well drained. The plant can survive short periods of flooding thus growing well in alluvial planes but needs free drainage as it does not tolerate water logging. Saline conditions have been found to reduce populations and produce chlorotic leaves. Soil fertility is important; thus phosphate fertilizers may need to be applied at planting.(Murphy and Colucci, 1999).

Forage Yield: Germination generally occurs within 5 days after planting. The growth period ranges between 75 to 300 days. Fruiting of some cultivars can be within 60-65 days of sowing and continues for 90-100 days. Mature seeds are harvested between 210 days after sowing (which varies with cultivar) (Evans, 2002).Once established, lablab is highly drought resistant often staying green during the dry season.

Chemical composition: Dry matter yield (g/plant) of *lablab purpureus* was 76.4 for leaf and 84.1 for stem in rongai variety (Karachi, 1997). The levels of crude protein reported by Karachi (1997) was 25% for leaves and 11.88% for stems. Evans (2002) reported a range between 12.7-14.1% for whole plant. The protein content of lablab (N *6.25) is higher than the recommended CP level for ruminant growth of 11% for young domestic ruminants. Aganga and Autlwetse (2000) reported a CP content of 16.4% for whole plant lablab hay.
The stem has greater NDF than the leaf, this is due to the amount of fibre and lignin in contains (Karachi, 1997). ADF is of particular interest as it is a good predictor of *in vivo* digestibility in a range of tropical legumes as *in vitro* digestibility (Shehu *et al*., 2001). The decline in the quality of both leaf and stem with increasing age reflects similar trends recorded in *L. purpureus*. Legume quality is affected by leaf:stem ratio. Leaf:stem ratio are more valuable in legumes because

the leaves are metabolic organs (Shehu *et al.*, 2001). It is important to note that both maturation and ambient temperature will affect various parts of the same plant differently. The quality of stems is largely affected because of their structural function (Shehu *et al*., 2001). Karachi (1997) reported mean NDF(14%) and ADF (29.6%) concentrations in leaf which were 20.5 units lower than that of the stem.

Digestibility: Digestibility of forage dry matter by the ruminant is the summation of the digestibility of the component tissues as affected by morphology, anatomy and chemical composition.
The DMD levels for the leaf are adequate to promote high growth rate in ruminants(Karachi, 1997). The *in vitro* dry matter digestibility of the leaf, 64.4% is 20% units higher than that of the stem (44.2%).

Animal Production: Many conventional diets in the tropics for ruminants are poor quality roughages typified by high NDF, low nitrogen and slow fermentation rates. This poor dietary combination leads to decreased intake, weight loss, increased susceptibility to health risks and reduced reproductive performance. Including herbaceous legumes in these feeds regimes helps to rectify some of the problems associated with low protein and high fibre diet (Murphy and Colucci, 1999). In a study where lablab was used as a supplement to oat hay, average daily gain in sheep fed the supplement was almost double than that of sheep fed solely the basal diet (Umunna *et al*., 1995). Lablab is a main fodder crop in Kenya, Zimbabwe , Botswana and the Sudan. Organic matter digestibility declines over time (61.3% in younger plants to 48.3% in older ones). Milk production from lablab was usually higher than from grasses. A feedy flavour in milk is reported with lablab feed. (Evans, 2002).

Agricultural applications: In addition to its potential as an enhanced nutritive feed source for livestock, *lablab purpureus* offers many other benefits when included in tropical agricultural systems. Being a legume, lablab, provides biological nitrogen (N) fixation. The natural action of converting atmospheric N into forms available for the plant- animals-soil system improves productivity in an inexpensive, environmentally friendly manner. (Murphy and Colucci, 1999). Lablab with its deep tap root is able to bring minerals, otherwise not available for annual crops, from the depths to the top soil. This deep root also serves to stabilize the landscape as soil erosion and runoff are reduced by leguminous covers (Murphy and Colucci, 1999). Lablab has also been known for its use as a green manure, adding organic matter as well as N and mineral to the soil.

Lucerne: Different names used for Lucerne are *Medicago sativa, a*lfalfa, lucerne ,buffalo herb, Chilean clover, father of all foods, purple Medic.

History and distribution: Alfalfa is native to Southwest Asia as indicated by occurrence of wild type in the Caucasus and in mountainous region of Afghanistan, Iran and adjacent regions. The cultivated forms probably arose in western Persia and then spread to become widely cultivated, often a weed throughout Asia, Europe and America.(Duke, 1983)

Plant description: Perennial herb; with erect stems or sometimes decumbent, 0.3-1 m long, 5-25 or more per crown, much branched, 4 angled, glabrous or the upper part hairy; rhizome stout, penetrating the soil as much as 7-9 cm. Stipules united 1/3 to 1/2 length, free portion triangular lanceolate, tapering, basally entire or with 1-2 teeth. Glabrous or sparingly appressed hairy; leaves pinnately trifolialate, leaflets obviate oblong, ovate or linear, tapering to base. Crenate above middle mostly retyuse and mucronate, 10-45 mm long, 3-10mm broad, glabrous or oppressed hairy, paler green beneath. Racemes oval or rounded, 1-2.5cm long, axillary, 5-40 flowered peduncles. Slender, firm always exceeding the subtending leaf, yellow or blue to purple or violet flower. The pods are slightly pubescent or glabrous, 3-9mm diameter, with 2-3 spirals prominently reticulate-veined seeds 6-8 per pod, with yellow, or brown colour. (Duke, 1983).

Agronomic characteristics: Alfalfa shows considerable variation in form and adaptation to environment. Form of plant varies from erect to decumbent from southern subtropical areas to northern regions and from lower to higher elevations. Length of vegetation period decreases from south to north and from lower altitude to higher elevations. Many strains are adapted to different climatic plains as in hilly regions, up to an altitude of about 2400 m . It can withstand high temperatures of 39-41^{o}C as well as rather low temperature, the degree of adaptability varying with different strains. Thrives particularly well in semi-arid regions under irrigation. Some clones that are self sterile at low temperatures may be partially self fertile at high temperatures. Annual rainfall of 5-6 dm is optimum (in the temperate regions), but crop will survive less. Soil moisture can be reduced to 35% of the water holding capacity of a soil before photosynthesis. In areas of high rainfall of 10 dm or more alfalfa does not grow well as a perennial. Annual temperatures ranges from 4.3 to 28.5 ^{o}C .
Lucerne grows on a variety of soils, but thrives on rich, friable ,well drained loamy soils. Alfalfa may be a bit more tolerant of frost and salt than wheat. Salinities of 3mmhos reduce yield by 10%, 5mmhos by 25%, 8mmhos by 50%. Deep penetrating roots make alfalfa

quite drought tolerant. pH ranges from 4.3-8.7.

Chemical composition: Dry matter yield of Lucerne was 90.76% DM in pellet form. Green forage of *Medicago sativa* is reported to contain per 100g, 80.0% moisture, 5.2g protein, 0.9g fat, 3.5g fibre and 2.4g ash. Alfalfa whole meal and leaf meal are reported to contain per 100g, 66 and 77 calories, 7.5 and 8.0% moisture, 16.0 and 20.4g protein, 2.5 and 2.6g fat 27.3 and 17.1g fibre, 9.1 and 11.5g ash, respectively. Alfalfa is a valuable source of vitamins A and E, it contains : - B carotene 6.24, thiamine 0.15, riboflavin 0.46, niacin 1.81, and " – tocopherol, 0.46, niacin 1.81, and pantothenic acid, biotin, folic acid, choline, inositol, pyridoxine, vitamin B_{12}, and vitamin K are also present. Fresh Lucerne is rich in vitamin C (1.78 mg/g) but it loses 80% on drying (Duke, 1983).

Yields: Forage yields are 5-75 MT/ha/year (with 8-12 cuttings per year). Seed yields are 186-280 kg/ha annually. Alfalfa is estimated to fix 83-594 kg N/ha (Duke, 1983).

Animal production: Alfalfa or Lucerne is a highly valued legume forage, extensively cultivated in warm temperate and cool subtropical regions. It has been heralded as having the highest value of all commonly grown hay crops, producing more protein per ha than other crop for livestock. In some areas it is used in combination with maize for silage(Duke, 1983). It is an excellent pasture for hogs, cattle and sheep, often in mixtures with grass. Supplemental feeding of grain of dairy cows, sheep and fattening cattle reduces bloating and balances the high protein level of the alfalfa pastures with energy and extends the usefulness of the pasture. Alfalfa meal is presently made into pellets and used in mixed feeds for cattle, poultry and other animals (Duke, 1983). Lucerne can also be used as fodder for chicken, horses, ostriches and Turkeys.

Agricultural uses: Alfalfa may be grown as a cover crop and often increases yield of succeeding crops as potatoes, rice, cucumber, lettuce, tomatoes. Extracts produce antibacterial activity against gram positive bacteria. Seeds yield 8.5 – 11% of a drying oil suitable for making paints and varnish. Seed screenings are ground and used to a limited extent in feeds for ruminants. (Duke, 1983).

Lucerne (*Medicago sativa*) at BCA farm: Non dormant variety of Lucerne was planted at BCA Farm. The selection criteria included demand and availability of water and climatic conditions of the area. Non-dormant variety is expected to be productive all year round.

Establishment, date of plant, vaccination: Planting took place in May 2001. The month of May was good time for planting of Lucerne because due to lowering environmental temperatures weeds growth was suppressed.

Lucerne was planted on a 6 ha field in 15 cm rows at the rate of 25kg/hectare with a seed drill. Seed was inoculated with *rhizobium* bacteria prior to planting. Seed was planted in leveled shallow but not compacted field. Germination took place between 10 and 25 days from planting. Later germination occurred where seed fell deeper in to soft soil. Irrigation was applied at about 5 days intervals to keep soil surface permanently moist and soft. Weeding was done manually when necessary.

Cultivation: For cultivation of alfalfa, land should be well-plowed. Farm manure could be applied six weeks before planting. As seeds have hard coat, they should be scarified or soaked in water before sowing. Seeds should be inoculated with the proper strain of inoculum. Crop may be sown pure or in mixture with grasses or other legumes. Seeds drilled in rows or on ridges 55 – 72 cm apart. Sowing on ridges facilitates weed control.

The colour of the growing lucerne varied from dark green-blue to bright green. Bright green spots indicated shortages of nutrients in the soil. Therefore 2-3-4 fertilizer was applied at the rate of 120 kg/ha. The first lucerne cut was done at the beginning of November 2001 and baled. Yield was 60 bales of about 20 kg each. After first cut, second doses of NPK 2-3-4 fertilizer was applied at the rate of 100 kg/ha. Lucerne field recovered quickly and second cut was done at the beginning of January 2002 and 250 bales of Lucerne hay bales collected from the field. Harvesting and hay making is done routinely on the farm as the Lucerne pastures recover from previous cutting .Lucerne swath need one to two days of drying on field before raking. Another day after raking is required to proceed with baling of hay. Routine application of 2-3-4 fertilizer is done when necessary especially after cutting.

Leucaena Leucocephala

Table 5: Different names used for *leucaena leucocephala*(lam) de Wit*

Common name	country
Leucaena	Austrlia
Ipil ipil	Philippines
Lamtoro	Indonesia
Katin	Thailand
Yin ho huan	China
Kababul or subabul	Hawaii
Koa haole	India
Tangantangan	some pacific Islands
Cassis	Vanuatu
Guaje	Mexico
Huaxin	Central America(Maya)

*(Gutteridge and Shelton, 1994)

Table 6: Dry matter yield (%DM) of *Leucaena Leucocephala*

Mean	whole plant	leaf	stem	variety conditions	Reference
		81.36			Rajendran *et al.* (2001)
		96.17			Khamseekhiew *et al.* (2001)

Table7: *L. leucocephala* crude protein content (% DM)

Whole plant	leaf	stem	seed	Reference
	24.0			Masama *et al.* (1997)
	20.9			Tudsri *et al.* (2002)
	29.5			Wheeler *et al.* (1996)
	21.99			Khamseekhiew *et al*. (2001)

Table 8: Fibre content of *L. Leucocephala* (% in DM)

Sample	Crude fibre	NDF	ADF	ADL	Reference
	11.84				Rajendran(1996)
			38.4	15.5	Karachi (1998)
			32.0	18.1	Castillo *et al.* (1997)
			37.4	18.7	Wheeler (1996)

History and Distribution: Leucaena has its origins in Central America and the Yucatan Peninsula of Mexico where its fodder value was recognized over 400 years ago by the Spanish conquistadors who carried leucaena feed and seed on their galleons to the Philippines to feed their stock (Shelton and Brewbaker, 1994). Leucaena is native throughout the West Indies from Bahamas and Cuba to Trinidad and Tobago, and from southern America. Naturalized northward to southern Texas, California and southern Florida, and southward to Brazil and Chile: also naturalized in Hawaii and the old world tropics. It has spread pantropically due to its value, particularly for forage, but also for wood, green manure and shade(Castillo *et al*., 1997).

Plant description: *Leucaena leucocephala* , formerly known as *L. glauca*, is a thornless long-lived shrub or tree which may grow to heights of 7-18 m. Leaves are bipinnate with 6-8 pairs of pinnae bearing 11-23 pairs of leaflets 8-16 mm long. The inflorescence is a cream coloured globular shape which produces a cluster of flat pods 13-18 mm long containing 15-30 seeds. Botanically, leucaena belongs to the family Mimmosaceae; it is best known species of the leucaena genus and has a variety of recognized names (Table 5). There are, at least 14 other species recognized in the genus. These *are L. collinsii, l cuspidate, l, diversifolia, L. esculenta, l. greggi, L. lanceolata, l. macrophylla, L. multicapitula, L. retusa, L. pallida, L. leucocephala and L. pallida and one subspecies of L. divesifolia* (Shelton and Brewbaker, 1994). *L . pallida and L. diversifolia* are partially domesticated and may have some potential for forage use. Their interspecific hybrids with *L. leucocephala* have seen superior yields and psyllid resistance in international trials (Castillo *et al*.,1997).

Agronomic Characteristic: *Leucaena leucocephala* requires long, warm, wet growing seasons, doing best under full sun. In Indonesia it is grown to 1.35 m and in Java to 1.08 m. Natural stands are found mostly below 500 m in area of 6-17 dm rainfall. Its growth rate is slower, at higher altitudes. About one dm per month is required for good growth. The plant is known for its drought tolerance. The lead tree thrives on a wide range of soils, but does poorly on acidic latosols unless Mo, Ca, S and P are added. Its deep root system permits it to tolerate many soil types, from heavy soils to porous coral. Ranging from warm temperate annual precipitation of 1.8 to 41.0dm, annual mean temperature of 14.7 to 27.4EC.(mean of 24.0 EC), and pH of 4.3 to 8.7 (mean of 21 cases = 6.1) (Duke, 1983).

Trees, propagated by seed or cuttings coppice well. Some seedlings less than one year old will produce viable seed. Seed remain viable from several months to several years. The hard waxy seed coat makes scarification necessary before planting. For forage, seed should be sown 2.5–7.5 cm deep, planting at onset of wet season. Lead tree responds favorably to fertilizer and lime. Irrigation and cultivation may be necessary. (Duke, 1983).

Leucaena is a deep rooted perennial shrub tree which requires a deep, well drained, neutral to calcareous soils; it is often found naturalized on the rocky coralline terraces of pacific islands countries. However, it grows on a wide variety of soil types including mildly acid soils (pH>5.2). It is well adapted to clay soils and requires good levels of phosphorus and calcium for best growth (Shelton and Brewbaker,1994).

Forage yield: The crop can be cut at mature stage for silage or fodder. Lead tree produced 56Mt/ha/year green forage in Hawaii at 24 m altitude. With adequate moisture yields of 80Mt/ha have been obtained. Two year old trees have yielded 4.5–7 kg pods per tree. Duke (1983) reported annual DM yields of 2-20 MT/ha, equivalent to up to 4,300 kg protein per hectare, nearly double the yields of alfalfa. Duke (1983) reported DM yields of 2-13 MT/ha/yr in Australia, 14-16 in Brazil, 15-50 in Cuba, 35 in Mauritius, 13 in New Guinea, 15-19 in Taiwan and 3-21 in the Virgin Islands.

Chemical composition: With its *rhizobium* , *leucaena* can fix more than 500 kg N/Ha. On 3-18 year trees, annual wood increments vary from 24 to over 100 m^3/ha averaging 30 to 40. Dry leucaena wood has 39% the caloric value of fuel oil (10,000cal/k), leucaena charcoal 72.5%. In, Molokai , Hawaii a 400 ha farm of *leucaena*

Table 9: Dry matter digestibility(DMD) of. *Leucena Leucocephala*

Sample	DM,% (mean)	Reference
L. Leucceophala (in vivo)	66.3	Castillo *et al.* (1997)
L. Leucocephala (*in vivo*)	57.3	Karachi (1998)
L. Leucceophala (*in vivo*)	57.7	Wheeler *et al.* (1996)
	66.2	Masama *et al.* (1997)

leucocephala on a four rotation is expected to fuel two megawatt facility producing 11.6 million KWh/yr. (Duke, 1983).

Khamseekhiew *et al*. (2001) reported that the crude protein (CP) of edible material (leaves and small stems) of *L. Leucocephala* ranged from 14-30%. It is generally accepted that *L*. *Leucocephala* can constitute up to 30% of the diet of unadapted ruminants without any of toxicity. The high crude protein in leucaena relative to grass highlights the importance of maintaining adequate quantities of high protein legume in the pasture and in the diet.

Table 8 summaries crude fibre, neutral detergent fibre (NDF), acid detergent fibre(ADF) and acid detergent lignin(ADL) values for the *leucaena leucocephala* plant and various fractions. The average crude fibre of the whole plant is 11.84% with the average NDF, ADF and ADL being 34.5, 24.7 and 15.5% respectively (on dry matter basis). One of the challenges of growing forage in tropical environments is the effect of environment on the nutritional characteristics of plants. High temperatures decrease the soluble carbohydrate content of plants, resulting in increased fibre content and decreased digestibility. Digestibility of forage dry matter by the ruminant is the summation of the digestibility of the component tissues as affected by morphology, anatomy and chemical composition (Murphy and Colucci, 1999).

The digestibility of forages is affected by the maturity of the forage. High polyphenols are believed to interfere with digestion and may also contribute to low DMD values (Karachi, 1998). Forage quality of *L. Leucocephala* is higher as compared to the other *leucaena* species like *L. pallida* and *L. diversifolia* as stated by Castillo *et al.,* 1997. The results of his study indicated that the previous two had higher cell wall and lignin concentration. Condensed tannin is known to complex with both protein and fibre and reduce digestibility of the plant.

Until relatively recently, there were few pests of *leucaena* because of the insecticidal properties of mimosine. The psyllids or jumping lice are small aphid-like insects adapted to feeding on the young growing shoots of *leucaena.* Mild infestations cause distortions of leaves whist heavy infestations result in loss of leaves and attack by secondary moulds which feed on the sticky exudates of psyllids (Shelton and Brewbaker,1994).

Conclusion: Given the current state of inadequate forage availability and importation of animals feed into the country. A discerning move into cultivated legume pastures is an absolute requirement for any major increase in protein forage production in the country. There is a need to incorporate cultivated legume pastures namely Lucerne, Lablab and *L. Leucocephala* into the farming systems and this requires high level of management and objective planning.

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