



Ministry of Agriculture and Livestock Development
State Department for Crop Development
P.O Box 30028, Nairobi



Emergency Locust Response Program
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2.4.2 SUB-MODULE 2. PASTURE AND FODDER PRODUCTION

Cattle, sheep and goats are the most common ruminants kept in the farms, whose production all over the world are primarily based on forages, with tropical countries invariably leading in heavy reliance on forages and crop residues throughout the year. For instance, majority of dairy herds on smallholder farms, largely depend on natural tropical grass pastures and crop residues for nourishment. Kenya and indeed the whole of East African region is widely recognized as the home for many important forages, of which some important ones are described below.

Napier grass (*Pennisetum claudatum*)



Napier grass

Strengths

- High dry matter yields.
- Very palatable, high quality forage.
- Drought tolerant.

Limitations:

- Needs high fertility
- Matures rapidly, becoming stemmy.
- Usually needs to be planted vegetatively



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Feeding value

- Extremely palatable to all classes of livestock when provided young and leafy
- Note: There is great variation in nutritional value depending on the stage of growth of the Napier grass.
- Young regrowth of about six weeks can have crude protein of about 10%, falling to 7.6% at 10 weeks growth. With good supply of nitrogen, protein levels can rise to almost 20% and digestible energy levels can vary from 68-74% in the same growth period. Once Napier starts growing stems, palatability and nutritional value quickly decreases to become almost value less for livestock.
- Should not be a sole diet, i.e be fed in mixture with other supplementary feeds such protein forages and concentrates to sustain high production.
- Companion species
- Grasses: Not sown with other grasses.
- Legumes: Normally not planted with legumes, but will grow with vigorous twining legumes such as Desmodium spp. or with the shrub/tree legume , *Leucaena leucocephala*



Inter-cropping of Napier and desmodium for improving nutritive value (left), and Napier -Vetch and intercrop at KALRO-Naivasha (right) (Photo: T. Lanyasunya)



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Naivasha star grass or Bermuda grass (*Cynodon dactylon*)



Naivasha star grass or Bermuda grass (*Cynodon dactylon*), and (right) Bermuda grass young regrowth mature for grazing (Photo: J. Ouda)

Grows in grassland, lawns and pastures and as a weed in cultivation. Locally dominant along roadsides and overgrazed and trampled areas.

Strengths

- Widely adapted to soils and climate.
- Palatable.
- High nutritive value when young.
- Excellent ground cover for soil conservation.
- Tolerant of heavy grazing.
- Makes useful hay.
- Tolerant of salinity.
- Tolerant of flooding.

Limitations

- Low production unless well fertilised.
- Can become a weed in cultivation.
- Difficult to eradicate.



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Nutritive value

Crude protein varies with age of material and level of nitrogen fertilisation, from about 3 -9% in old grass, to about 20% in young, well-fertilised grass. Dry matter digestibility varies from 40 - 69% with genotype.

It is very palatable if kept short in growth and fertilized. Excellent grazing for village geese, ducks, goats, cattle and buffaloes if not trampled too much by these latter heavy beasts. The rhizomes are given to horses. Biomass productivity depends on the cultivar used, the time of year and the amount of nitrogen available. Dry matter (DM) yields of 1,000-3,000 kg/ha per month. 'Coastal' yields up to twice as much as most common ecotypes. Annual DM yields are generally of the order of 5-15 t/ha.

*Elephant grass (*Panicum maximum*)*



Elephant grass (Photo: J. Ouda)

Widely naturalised in the tropics. It grows naturally in open grasslands, usually under or near trees and shrubs, and along riverbanks.

Uses/applications

Long -term pasture if fertility is maintained. Ideal for cut-and-carry, although bristly types may cause discomfort to forage collector. Suited to agroforestry due to shade tolerance. Reasonably palatable when mature, providing good roughage for use in conjunction with urea molasses licks. It has been used successfully for making silage and hay.



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Production potential

Dry matter. Commonly (10-) 20-30 (-60) t/ha DM, depending on variety and growing conditions (particularly if high levels of N applied).

Animal production. Can achieve up to 0.8 kg/hd/day LWG and up to 1,200 kg/ha/yr LWG (commonly 300-500 kg/ ha/yr LWG) depending primarily on stocking rate and N fertiliser rate.

Strengths

- Very leafy.
- High quality feed.
- High production potential.
- Readily eaten by all stock.
- Suited to grazing and cutting.
- Drought tolerant.
- Early season growth in some lines.

Limitations

- Requires fertile soils.
- Intolerant of waterlogging.
- Intolerant of heavy grazing.
- Becomes stemmy if not cut or grazed frequently.



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Sorghum (*Sorghum bicolor*)



Sorghum at onset of flowering and at grain maturity stages in Narok (Photo: J. Ouda)

Uses/applications

The various types of hybrids have different agronomic features and uses.

Sweet sorghum hybrids tiller well, are tall with fine stems, flower early and have low prussic acid. They grow rapidly but some cultivars selected for later flowering are easier to manage as they remain leafy for longer.

Feeding value

Moderately palatable and digestible when young. The sweet sorghum hybrids keep a higher free sugar content in the stem and are more suitable as stand-over feed in dry season.

Toxicity

Leaves can be poisonous to grazing livestock due to hydrogen cyanide (prussic acid), especially in young dark-blue coloured regrowth after a dry spell.

Strengths

- Easy establishment and rapid growth.
- Very productive on fertile soils.
- Pioneer species with other perennial grasses or legumes.



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Limitations

- Demands high soil fertility.
- Prussic acid poisoning.
- Seed cannot be distinguished from that of *S. halepense*.

African foxtail grass (Cenchrus ciliaris)



African foxtail grass

Widely naturalised in sub-humid and semi-arid tropics and sub-tropics.

Uses/applications

Mainly used as a permanent pasture, but can be used for hay or silage. Not suited to short-term pasture because too difficult to remove and binds nutrient.

Moisture

The most drought tolerant of the commonly sown grasses, *Cenchrus ciliaris* occurs naturally in areas with average annual rainfall from as low as 100 mm up to about 1,000 mm, but most commonly between 300 and 750 mm. Under cultivation, it has been grown in areas with rainfall as high as 2,900 mm, although this is exceptional. Does not survive prolonged waterlogging, particularly in cold season, but can stand up to five days of flooding with negligible adverse effect. Losses of 15-70% occur after 20 days of flooding. Tolerance of flooding varies with ecotype, the taller varieties appearing to be more flood-tolerant.



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Defoliation

Slow to establish and grazing may need to be delayed 4-6 months after sowing, and up to 9-12 months, depending on establishment conditions. Very tolerant of regular cutting or grazing. Since quality declines rapidly with age, should be cut or grazed at least every eight weeks. Leafiness is maintained by low cutting at about 7 cm.

Fire

Very tolerant of, and favoured by fire. Cover of *Cenchrus ciliaris* can increase, and populations of associated fire-susceptible species decrease in a fire regime.

Compatibility (with other species)

Cenchrus ciliaris is a particularly aggressive grass, by virtue of its extensive root system competing with associated species for water and nutrients. It also appears to be allelopathic (suppression of other species by exudation of phytotoxic chemicals that inhibit germination and growth of other plants).

Feeding value

Protein values are mostly in the range of 6-16%, and digestibility from 50-60%, depending on age of growth, cultivar, and soil fertility (incl. fertiliser use). P levels are usually higher than in other tropical grasses and range from 0.15-0.65% in the DM. Yields depend greatly on soil fertility and growing conditions, but are mostly in the range of 2-9 t/ha DM, and under ideal conditions, up to 24 t/ha DM. It can carry up to 1 steer or 6 sheep/ha, depending on rainfall and soil fertility. Cattle can gain up to 180-200 kg/hd/yr at 2 ha/beast on fertile soils under good growing conditions.

Strengths

- Persistent.
- Very drought tolerant.
- Quick to respond after rain.
- Widely adapted.

Limitations

- Needs high fertility for production.
- Establishment is difficult on clay soils.



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- Will not survive prolonged flooding or waterlogging.
- Can cause ‘big head’ in horses.
- “Fluffy” seed is difficult to sow.
- Threat to certain sub-humid to arid environments.

Leucaena



Leucaena at KALRO-Lanet (Photo: JO Ouda)

Uses/applications

It is highly valued as ruminant forage and as a fuelwood by subsistence and semi-commercial farmers throughout Southeast Asia and parts of central Asia and Africa.

It can be planted in hedgerow systems with grass for cattle production. Can also be used as a shade tree over coffee and grown in dense rows as a living fence and used to support vine crops such as pepper and passion fruit. It is a highly researched species for alley farming systems.

Moisture

It prefers subhumid and humid climates of 650-1,500 mm and up to 3,000 mm annual rainfall and tolerates up to seven months dry season. It does not tolerate waterlogged soils or extended periods of flooding (>3 weeks).



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Defoliation

It is extremely tolerant of regular defoliation by cutting or grazing once established.

Fire

Mature plants are tolerant of fire, re-growing readily from burnt stumps. Fire can be used to reduce height of grazed hedgerows, although productivity in the subsequent year may be poor.

Compatibility (with other species)

Compatible with a range of grass species. Can be difficult to establish leucaena into existing grass pastures without complete grass control or clean cultivation. In the dry tropics, can be difficult to establish a grass into mature leucaena due predominantly to competition for moisture. Grass establishment can be particularly problematic on strongly self-mulching clay soils.

Companion species

Grasses: Can be grown with buffel grass (*Cenchrus ciliaris*), Elephant grass (*Panicum maximum*). Rhodes grass (*Chloris gayana*) normally grown as a hedgerow with grasses or crops grown between hedgerows. Can be grown as a sole species as a protein bank.

Feeding value

Leucaena leucocephala foliage is noted for its very high nutritive value for ruminant production. Typical values for the edible fraction are 55-70% digestibility, 3-4.5% N, 6% ether extract, 6-10% ash, 30-50% N-free extract, 0.8-1.9% Ca and 0.23-0.27% P. Na levels are generally below requirements for ruminants at 0.01-0.05%. Leaves also contain 2-6% condensed tannins (CT), phenolic compounds which bind and protect dietary protein from degradation in the rumen. Providing that the protein-CT complexes dissociate post-ruminally allowing N absorption in the lower gut, CTs have the potential to increase protein uptake.

Palatability/acceptability

It is highly palatable to most grazing animals, especially compared to other forage tree legumes such as Calliandra (*Calliandra calothyrsus*) and Gliricidia (*Gliricidia sepium*).



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Toxicity

Contains mimosine, a non-protein amino acid that has antimitotic and depilatory effects on animals. Concentrations in young leaf can be as high as 12% and the edible fraction commonly contains 4-6% mimosine. Mimosine is acutely toxic to animals but is normally converted to 3-hydroxy-4(1H)-pyridone (DHP) upon ingestion. DHP is goitrogenic and, if not degraded, can result in low serum thyroxine levels, ulceration of the oesophagus and reticulo-rumen, excessive salivation, poor appetite and low liveweight gains, especially when the diet contains more than 30% leucaena. The anaerobic rumen bacteria, *Synergistes jonesii*, occur in most countries in the Americas and Southeast Asia and completely detoxify DHP and its breakdown products.

Production potential

Yields of forage vary with soil fertility, rainfall, altitude, density and cutting frequency from 1-15 t/ha/year. Leaf yield is maximised by cutting at 6-12 week intervals during the growing season. Yields in extensive hedgerow plantings in the dry tropics and subtropics generally range from 2-6 t/ha/year. Very high yields (>15 t/ha/year) in Southeast Asia and Hawaii, with plants 0.5-1.0 m apart in rows 1-3 m apart. Fuelwood yields compare favourably with the best tropical trees, with height increments of 3-5 m/year and wood increments of 20-60 m³/ha/year for arboreal varieties.

Animal production

Excellent growth rates of 1.26 kg/head/day for cattle grazing leucaena-buffel grass (*Cenchrus ciliaris*) pastures over 6-months were reported in Queensland, Australia, although growth rates are more commonly 250-300 kg/head/year (0.7-0.85 kg/head/day). Under irrigation in northwestern Australia, annual liveweight gains of up to 1,700 kg/ha/year have been recorded for cattle grazing at 6 head/ha.

Feeding value

Nutritive value. Leucocephala foliage is noted for its very high nutritive value for ruminant production. Typical values for the edible fraction are 55-70% digestibility, 3-4.5% N, 6% ether extract, 6-10% ash, 30-50% N-free extract, 0.8-1.9% Ca and 0.23-0.27% P. Na levels are generally below requirements for ruminants at 0.01-0.05%.

Leaves also contain 2-6% condensed tannins (CT), phenolic compounds which bind and protect dietary protein from degradation in the rumen. Providing that the protein-CT complexes dissociate



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post-ruminally allowing N absorption in the lower gut, CTs have the potential to increase protein uptake.

Palatability/acceptability. It is highly palatable to most grazing animals, especially compared to other forage tree legumes such as *Calliandra calothyrsus* and *Gliricidia sepium*.

Strengths

- Very high nutritive quality for ruminant livestock.
- Highly productive on suitable soils.
- Tolerant of prolonged dry periods and retains leaf into dry.
- Produces multiple products in a wide range of farming systems.

Limitations

- Poorly adapted to acid infertile soils.
- Poor growth at low temperatures and is susceptible to frosting.
- Relatively weak in seedling stage and slow to establish.
- Mimosine and condensed tannins limit use for non-ruminant livestock.

Lablab purpureus



Lablab at KALRO-Naivasha (Photo: J. Ouda)

Strengths

- A dual purpose legume can be used with cereals in smallholder systems.



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- High quality.
- As a green manure crop restores soil fertility
- Drought tolerant once established.
- High grain yields.
- Better root disease resistance than cowpeas
- Has considerable potential as a multipurpose legume in crop-livestock systems where rotations are possible.

Limitations

- Annual or short-lived perennial
- Poor frost tolerance.
- Host to pests attacking field beans.
- Indeterminate flowering leading to extended seeding period in current cultivars.

Compatibility (with other species)

In smallholder systems, lablab can be intercropped with maize. The lablab should be sown about 28 days after the maize to avoid severe cereal crop yield depression from competition.

Companion species

Grasses: Sorghums, millets and maize

Feeding value

Leaf has CP content of 21-38%, commonly about 26%. Much lower for stem (7-20%). Grain contains 20-28% CP.

Digestibility ranges from 55-76%, commonly >60% (leaves). Grain high in vitamins A, B and C.

Palatability/acceptability

Leaf is highly palatable, but stem has low palatability. Palatability of grain is low to moderate depending on variety.



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Toxicity

Leaf does not contain anti-nutritive factors such as tannins. Mixed plantings with forage sorghum prevents the occurrence of bloat. Grain contains tannins, and phytate and trypsin inhibitors. Concentrations vary among varieties. Soaking or cooking reduces the activity of these compounds.

Production potential

Seasonal yields of 2 t/ha leaf or 4 t/ha stem and leaf are common in sub-humid sub-tropics. Dry matter yield is usually higher than for cowpea, particularly under drought conditions. For human nutrition, 2-7 t/ha green pods. In monoculture, 1-2.5 t/ha DM, depending on cultivar.

Animal production

Good weight gain e.g. 350 g/head/day in zebu cattle fed maize stalk-lablab mixture achievable

Seed production

Intermittent flowering and pod production. Grain maturation on the forage cultivars is not uniform but crop landrace types often have more synchronous maturity. High grain yields of 1-2.5 t/ha, depending on cultivar, but when grown on trellises in smallholder systems the grain yields can be far greater. In mixtures with other crops, grain yields 0.5 t/ha. Late seeding varieties may be affected by early frosts. Lablab accessions with light coloured seeds have poor storage potential, which in turn affects seedling vigour and establishment

Desmodium



Desmodium at KALRO-Naivasha (Photo: J. Ouda)



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Strengths

- For cooler regions.
- Long growing season.

Limitations

- Poor persistence especially under heavy grazing.
- Needs fertile soils.

‘Silverleaf’ variety is usually grown with grasses that are also cold-tolerant, for example *Setaria*. Can be grown with creeping grasses but does not persist under heavy grazing.

Companion species

- Grasses: *Setaria sphacelata* , *Chloris gayana* , *Pennisetum clandestinum* , *Paspalum notatum*
- Legumes: *Desmodium intortum*, *Macroptilium atropurpureum*.

Feeding Value

Nutritional value is high although tannin levels can exceed 3%. This can act as ‘by-pass’ protein increasing the efficiency of digestion, but also slows nitrogen cycling from leaf drop.

Palatability/acceptability. The high tannin levels reduce palatability until stock acquire the taste for it.

Production potential

Legume yields of 4–7 t/ha and legume/grass yields of 15 t/ha DM have been recorded, with increases of 90–150 kg/ ha in soil nitrogen.

*Lucerne (*Medicago sativa*)*



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Lash Lucerne before flowering at KALRO-Naivasha (Photo: J. Ouda)

Uses/applications

Lucerne was one of the first forage crops to be domesticated. It is used as multi-purpose forage, able to be used for both grazing and conservation (hay, silage, meal and forage dehydration). It can be sown as a pure stand or in mixtures with both temperate and tropical grasses. The seed can also be used for human consumption as sprouts.

Feeding value

It is usually considered the ‘King of Fodders’ because it grows throughout the year if soil moisture is available. Protein and calcium levels are high, relative to other fodders, but metabolizable energy (ME) and phosphorus levels are low. ME and phosphorus levels are good in young growth but drop rapidly as the foliage matures. Intake of digestible nutrients by livestock is higher than for most other forages. Level of fibrous tissue is low and this allows rapid passage through the rumen. Lucerne foliage is highly digestible.

Palatability/acceptability

Lucerne is highly palatable. There are some cultivar differences in palatability and this is thought to be the result of different protein fractionations.



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Toxicity

Bloat is the major limitation to grazing lucerne. A combination of management and control measures can be used to reduce the risk of animals bloating on lucerne. Hungry animals are more at risk of bloat so provide animals with access to a source of roughage before or during grazing. There is usually reduced risk of bloat in mixed stands under rain grown conditions. Access to anti-bloating agents (drenching, in their water supply, rumen capsules or sprayed on foliage) is essential in intensively grazed situations.

Production potential

Under irrigation, lucerne is capable of producing 25-27 t/ha dry matter in the first year of a stand and this can fall to as little as 8-15 t/ha by the third year. Production can be related to plant density, level of disease and pest resistance. Under rain-grown situations it is also determined by availability of soil moisture. Good irrigated stands can produce 20 t/ha of hay per year (allowing for at least one spoiled cut per year). An utilisation figure of 50% is expected under grazed conditions.

Animal production

When green feed is available, daily liveweight gains for beef cattle will be around 0.7 kg/head/day compared with 1 kg/head/day on oats, improved tropical pasture and native pasture. This reduced weight gain is a result of the lower energy availability. However lucerne grows throughout the year so, over the full year, supplementing native pasture with lucerne can increase gains from 0.5 to 0.7 kg/head/day at double the stocking rate. Irrigated lucerne can carry a beef cow and a calf on 0.5 to 1 hectare on a year-round basis. Supplementing dairy cows grazing tropical grasses with lucerne can raise milk production from 10-12 to 14-15 L/cow/day. This can increase to 20 L/cow/day if the cows are further supplemented with grain to combat the energy deficiency. Sheep numbers can be increased from 6 to 15/ha by supplementing native pasture with lucerne. Irrigated lucerne can carry more than 80 dry sheep equivalents/ha from October to May.

Strengths

- Year-round production.
- High quality.
- Ability to extract water from deep soil layers.
- Persistent.
- Wide range of climatic adaptation.
- Responsive to irrigation.



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Limitations

Low energy levels.
Restricted soil adaptation (fertile, well-drained).
Cannot stand continuous grazing.
Causes bloat.
Susceptible to waterlogging.