UNIT I: INTRODUCTION TO PASTURE PRODUCTION

Sustainable and profitable livestock production can be achieved through proper production, utilization and management of pastures and forages worldwide. Pasture and forage crops remain the primary sources of feed for different categories of livestock in Uganda.

Pasture production is paramount to the development of any livestock enterprise especially under situations where profit gain and environmental sustainability are the goals of the production. Nature has set plants to be the primary producers of energy to other animals including man. There is a direct or indirect relationship between pasture species and livestock performance depending on the management. While ruminant livestock such as cattle, sheep and goats can graze or browse the pasture, others such as pigs, poultry, rabbits, and equines (donkeys and horses) have the ability to ingest some amounts of fibrous forages, which ferment in the caeca and provide the animals with some energy for physiological activities.

Pasture is defined as an area of land covered with grasses, herbaceous legumes, forbs, shrubs, and trees used for livestock feeding or environmental protection. This is usually referred to as grassland.

Fodder are plants grown primarily for livestock feed to be either harvested for hay, silage, or green feed, but excluding concentrates and other industrial by-products. Pastures and forages could be artificially sown or occur naturally. Natural or native pastures are found in rangelands, river banks, road sides and abandoned lands while sown pastures are found in commercial farms, universities, colleges of agriculture and some research institutes in Uganda

Advantages/Role of Pastures in Ugandan Agriculture

Pastures have the following advantages in Ugandan farming systems:

- Pastures and fodder crops are the cheapest form of animal feed available (in term of quantity and quality). A constant supply of good quality forage in sufficient quantities is a basic necessity in livestock farming.
- Pastures and fodder, particularly the leguminous types, improve soil fertility through their ability to fix nitrogen.
- They help to protect and conserve the soil thereby preventing damages
- They are used as part of rotation system such as ley pastures
- They are used for site stabilization in dams, under bridges and in lawns etc

- They serve as sources of income to many Ugandans through sales of conserved forage
- They are used in recreational centres such as stadia, play grounds, open spaces etc
- They serve as sources of vitamins e.g., vitamins A and B which are needed for healthy living
- Products from pasture finished livestock are higher in omega-3 and conjugated linoleic acids which help to decrease blood cholesterol level and decreases cancer risks
- They serve as a source of employment to Ugandans especially in the area of forage conservation and marketing

Benefits of fodder shrubs (Trees)

- By growing their own high-protein fodder shrubs on the farm, farmers can increase milk production without having to buy dairy meal. This translates into extra income as well as extra milk for the family.
- Fodder shrubs take up little land; this means that they can be managed as hedges on sites where food and cash crops are not planted, such as: external and internal farm boundaries, along farm paths, across slopes as soil conservation structures.
- Fodder shrubs provide a valuable feed supplement for dairy cows and goats, especially during the dry season. Their clear benefits have resulted in their widespread adoption in many parts of East Africa.
- They can be grown on land which would not be used for crops.
- They can replace existing hedges which have no other productive purpose. When managed well, they do not reduce the yields of crops growing next to them.
- With more fodder shrubs growing on the farm, there is less need to collect leaves from wild trees in the bush. This reduces the time and effort spent looking for fodder, which is particularly helpful to women, as well as reducing the pressure on nearby natural forest and bush land.

UGANDAN GRASSLAND TYPES

As a result of the influence of soils, climate, topography and land development, Uganda has six major natural grassland communities which are associated with the farming systems and agroecological zones. The natural pastures of Uganda are fairly productive and contain many desirable grasses and browse plants. They are, therefore, a valuable natural resource, which if well managed can be very productive. The natural grasslands have little or no legume component leading to low dry matter yields and poor nutritive value for the greater part of the year. The present poor utilization and low productivity is largely attributed to lack of well-articulated management guidelines for these grasslands

The six major natural grassland communities are:

1. Pennisetum purpureum grassland

This is a coarse grassland dominated by P. purpureum (Elephant grass); it occurs in the better watered areas between 1000 and 2000m above sea level with fertile soils. P. purpureum is an important fodder, though it is often grazed under lax management. Other grasses of grazing value associated with P. purpureum are Brachiaria spp, Cynodon nlemfuensis, Panicum maximum and Hyparrhenia rufa.; the only legume is Neonotonia wightii. Useful introduced legumes include Centrosema pubescens, Macroptilium atropurpureum, Desmodium intortum, D. uncinatum. Fodder grasses used are P. purpureum, Tripsacum laxum, Setaria splendida; herbaceous legumes are Lablab purpureus and Stizolobium spp. Tree legumes in use include Leucaena leucocephala, Calliandra calothyrsus and Sesbania sesban.

2. Moist Hyparrhenia grassland

The grass stratum of this moist savanna community is dominated by H. rufa and P maximum which occur on fertile soils with annual rainfall of 1000–1500mm. Other common grasses important for grazing are Chloris gayana, Brachiaria spp., H. variabilis and Imperata cylindrica var. africana. Most of the grasses and legumes suitable for this system are those mentioned in the grassland community above. Crop residues are a source of livestock feed in this system.

3. Dry Hyparrhenia grassland

This is found where growing conditions are not as favourable as for the previous one. The dominant species are H. filipendula and H. dissoluta in the dry Combetrum savannas. Other grasses are Setaria sphacelata, Themeda triandra, Cenchrus ciliaris, Cynodon nlemfuensis and grasses of minor feed value like Andropogon gayanus, A. schriensis, and Heteropogon contortus. The quality of the herbage is rather low, especially in the dry season because they grow in dry, poor places.

4. **Themeda triandra grassland**

This is a fire-climax community of the southern cattle corridor stretching from the shores of Lake Kyoga to the Tanzanian border. It is very nutritious when young. It occurs in savanna communities associated with Acacia spp., on light texture soils at altitudes of 1200 metres. Some of the Acacia trees, for example, A. hockii are important as fodder. Shade loving grasses like Brachiaria brizantha and Panicum maximum thrive amongst Acacia, provided that the trees are scattered. Other important grasses are Chloris gayana, Cynodon nlemfuensis, and Setaria sphacelata. The grazing value of the grasses is being reduced by weeds such as Cymbopogon afronadus and Imperata cylindrica. Some of the adapted forages include Leucaena leucocephala, Stylosanthes spp. and Calliandra calothyrusus

5. **Setaria-Chrysopogon grassland**

This community covers substantial areas of the north-eastern part of the country; it is dominated by Setaria incrassata which is characteristic of the clay plains of Karamoja. Other common grasses are Themeda triandra, Sorghum spp., Eriochloa nubica and Dichanthium papillosum. The annual rainfall is 750–1000mm. Further east, under rainfalls of 350–500mm, are the Chrysopogon clay steppes of Karamoja which provide moderate grazing. Bush and thickets occur at altitudes of 1200–2000 metres on shallow soils with 300–850mm rainfall. These communities, which contain a great variety of species, provide a lot of browse, but the grass cover is sparse

6. **Montane grassland**

Grass savannahs with abundant Andropogon distachyus, Cenchrus validus, Exotheca abyssinica and Hyparrhenia cymbaria have developed at altitudes of 2000–3000m. The most productive grasses are Pennisetum clandestinum and P. purpureum followed by Setaria sphacelata found on Mt. Elgon, in the East and Southern Kigezi and on the foothills of the Rwenzori Mountain. The P. clandestinum grasslands have a natural clover Trifolium semipilosum (Kenya white clover) which is very compatible with the grass

IMPORTANT PASTURE GRASSES IN TROPICS

1. **Panicum maximum: Common names: Guinea grass**

Origin and distribution: It's a native of tropical Africa and has spread to many warm countries like Australia, South States of USA, and Philippines.

Figure 30: Field photos of Panicum maximum

Climate: Warm and moist climate of semi-arid tropics is an ideal situation for this grass.

Soils: It grows best in well drained, medium, and fertile soils under shades, but in high rainfall areas or under irrigated conditions it is found even on loamy soils.

Cultural practices: It requires well prepared land (2-3 times ploughed up with 3-4 harrowings). Pasture is easily established by planting rooted slips in lines at about 1 m distance in rows and 50 cm between plants during the rainy days under rainfed conditions. When it is established through seed, 3-6 kg seed/ha. One-two weedings are needed after establishment to check the weeds.

Fertilizer application: It is better to grow it along the irrigation channels, gardens, and orchards etc. Being highly responsive to manuring 10 to 20 tonnes FYM + 30 kg P_20/ ha as basal dose, besides top dressing with 50-60 kg N/ha in two doses after every cut are given. After a period of 4-5 years the pasture needs to be replanted due to its ageing which can be done in the inter spaces of the standing crop

Management schedules: Generally, Guinea grass pasture is ready for first cut after 60 days of planting and subsequently at monthly (30-40 days) intervals. cuts. However, at sewage irrigation 225.0 t/ha (green) forage may be obtained in 12 cuts.

Nutritive value: It contains 5-8 per cent C.P depending on the stage of clipping.

Utilization: This grass can be used both for, grazing and soiling but being preferred for silage. It is the best to keep it below l' m. height for maximum quality forage. After the pasture grazed, it can be cut back to 10-15 cm height for early regrowth. It is a better fodder than jowar and maize.

Cultivars: Its cultivars are Hamil panic, Coloniao, Makueni, Gramalote, Silky Guinea, Riversdale, Embu, Coarse Guinea, Common Guinea, Likoni Guinea etc.

2. **Chloris gayana: Common name: Rhodes grass**

Distribution: It is a native of South Africa and was named after the famous Cecil Rhodes, who popularised it.

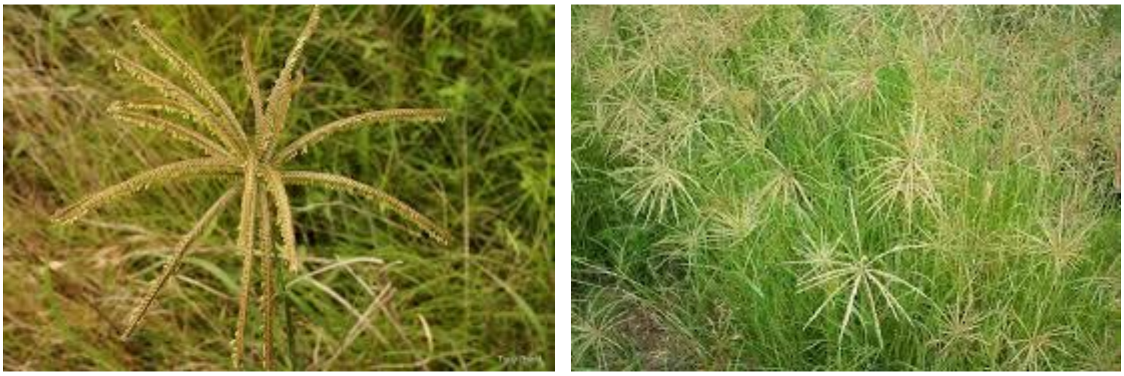


Figure 31: Field photos of Chloris gayana

Climate: It grows well in warm-moist conditions.

Soils: It prefers loamy to sandy loams and can grow even on a fair degree of salinity but cannot withstand stiff clayey or waterlogging conditions.

Cultural practices: It can be established by seeds as well as by rooted slips. The establishment by seed is cheaper and for this firm seed bed is prepared on well ploughed land and seeds are broadcast at a rate of 5 kg/ha at the onset of rains by mixing the moist soil. In high rainfall zones or under irrigated condition higher seed rate (10 kg/ha) is recommended or rooted slips can be transplanted in the lines at a distance of 50x50 cm for which nearly 40,000 slips are required for one hectare. 1-2 interculturing and gap filling are required in the first year to ensure good establishment.

Fertilizer application: Since this grass responds well to manuring, 10-15 tonnes of FYM or compost along with 30 kg P/ha as basal dose followed by 20 kg N/ha as top dressing for ensuring sustained productivity. In case of irrigated crop, irrigation after every 2-3 weeks along with 20 kg N/ha increases the forage production.

Forage yield: In pastures raised through seeds, first clipping can be taken after 3 months, while that from rooted slips after 2 months and subsequently after every month in both types of pastures. Thus, nearly 6 cuttings with an average yield of about 17.0 t/ha (green) are possible under rainfed conditions but under irrigation the yield is as high as 175.6 t/ha.

Nutritive value: At pre-flowering stage C.P. is nearly 5 per cent with a balanced content of Ca (0.5 per cent) and P (0.3 per cent).

Utilization: The grass is suitable for pasturage, silage, and hay but it is generally used for soiling. Even after severe trampling it provides grazing up to September and could be utilized for hay thereafter.

Compatibility: It grows well with Stylosanthes guianensis and Neonotonia wightii and consequently 20 and 100 per cent increase in forage yield was recorded respectively.

3. **Setaria sphacelata: Common names: Setaria**

Origin and distribution: The name of this grass 'Setaria' is derived from Latin 'Seta' the meaning of this is numerous bristles on the inflorescence. It is native to tropical Africa.


Figure 32: Field photos of Setaria sphacelata

Climate: This is a grass of warm climate and is found in the rainfall zone of 1500 mm in plains.

Soils: It thrives well on fertile loamy soils and comes even on light soils (sandy-loam).

Cultural practices: It can be established by planting seedlings/rooted slips in furrows of 50 cm apart and 30 or 50 cm distance from plant to plant. In case of establishment by seed, seed rate is 1.5 kg/ha for mixed pasture.

Fertilizer application: It shows linear response to manuring and generally 20 tonnes FYM along with 120 kg N + 60 kg P_20_5 as a basal dose followed by 20 kg N/ha after every cutting or 40 kg N/ha after every two cuts ensures high forage yield.

Management schedule: Generally, the pasture is ready for first cutting after 3 months of planting (sowing) and subsequently it can be harvested at monthly intervals in a well irrigated and properly manured pasture. The cutting height may be kept between 5 to 10 cm from ground level.

Forage yield: The pasture of Nandi grass produces 22.8 to 23.8 t/ha green forage under rainfed condition, but two protective irrigations increased the forage yield up to 61.2 t/ha with nearly 30 per cent dry matter content. This grass is more potential and under good management (well fertilized and irrigation), the pasture yielded 89.6 t/ha in 7 cuttings in south and 120 t/ha

Seed yield: Cultivar Nandi yields 112 kg seeds/ ha, but the seed yield seldom exceeds 330 kg/ ha

Nutritive value: The grass is very leafy and quite palatable and highly nutritive. It contains 5.3 per cent CP in unfertilized pasture but the application of 30 kg N/ha increased CP (6.9 per cent).

Utilization: The grass can be used for soiling, hay or grazing particularly due to its good winter growth which ensures its sustained forage supply round the year, especially if intercropped with legumes such as stylo and siratro.

Cultivars: Nandi, Kazungula, Narok are its main cultivars.

4. **Cynodon dactylon Common names: Bermuda**

Distribution: native to India. It was introduced from Behama Island in other countries like United States, and therefore it is also known as Behama grass. It is found in almost all the tropical and subtropical countries of the world from sea level to 2,130 m elevation.

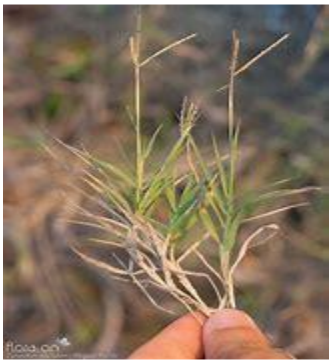


Figure 33: Field photos of Cynodon dactylon

Climate: It grows well in semi-arid conditions between 300-2000mm rainfall but does not survive in low rainfall areas

Soils: This grass thrives best on heavier silt and clayey soils not Subjected to waterlogging or flooding. Sandy soil also does not suit to this grass. It is resistant to a great extent to drought and tolerant to salinity and alkalinity.

Cultural practices: After proper land preparation by 2-3 ploughing, the best establishment of this grass can be achieved through planting of cut pieces of stolons with 2-3 rooting nodes (runners) during rainy season at 30-50 cm distance. After planting the field needs to be pressed by a light roller or feet. Establishment through seeds is not very successful, because the seeds are very minute, and their germination is very slow. Moreover, by the time small seedlings emerge from seeds they are smothered by other weed species.

Fertilizer application: This grass gives linear response to N-fertilizer and to increase the forage production 120 kg N/ha may be given

Forage yield: Generally, grass is ready for first cut in 3-4 months after planting and for subsequent cuttings after every two months interval and thus 4-5 cuttings may be taken every year. The average green forage yield ranges from 15.0-16.0 t/ha (4.0-5.0 t/ha dry matter) under rainfed conditions. However, under irrigated conditions with 120 kg N/ha in 2-3 cuttings 30.0-35.0 t/ha green fodder (90-110 t/ ha dry matter) can be harvested.

Nutritive value: It contains 11.1 per cent C.P. in young stage and about 7.0 per cent at maturity and least crude fiber (18.6 to 28.2 per cent).

Utilization: Being most nutritive, the grass is readily eaten by all types of livestock. It is used as green fodder or may be converted into excellent hay or grazed in situ. In addition to this, it is extensively used for checking soil erosion, gully plugging on check dams, embankments. of rivers, canals, and other sloppy stabilization programmes of reservoirs etc.

5. **Pennisetum clandenstinum: Common names: Kikuyu grass**

Origin and distribution: It's native to South Africa.

Climate: It prefers cool and moist climate up to the elevation of 1500 m. It requires average rainfall of 1269 mm every year.

Soils: It grows well in rich loamy and acidic soils.

Cultural practices: This grass could be established by vegetative propagation through root runners planted at a distance of 75 cm apart on a well prepared and manured soil at the onset of rainy season. When established through seed 2-4 kg/ha seed is sufficient. The grass spreads rapidly by means of both surface and subterranean stolons. With a period of 3 to 12 months the crop attains a height of 1 m and whole of the Held gets covered. It needs to be replanted after every two years, otherwise the plants become too hard for grazing and pasture loses the productivity.

Figure 34: Field photos of Pennisetum clandenstinum

Fertilizer application: At the time of field preparation 10-15 tonnes FYM/ha should thoroughly be mixed and afterwards 60 kg N/ ha/yr in 2-3 splits produces optimum forage yield

Management schedule: First cut can be taken after 3 months of establishment and further cuts at an interval of 1 -1 1/2 month may be taken.

Forage yield: The average total green forage yield is 35.0-40.0 t/ha.

Seed yield: In first year the seed yield is 25 kg/ha but in well-established and under good management it is up to 500 kg/ha.

Nutritive value: At early stage i.e. 30 days after transplanting it is relished by all kind of animals. The average CP of the crop is over 12 per cent.

Utilization: Being highly nutritive and palatable it is a very good feed for dairy cattle. They relish it well due to its high leaf/stem ratio and succulent nature. It can stand close grazing. In addition to this the grass is very useful for erosion control on hills, since it is aggressive due to its spreading growth and has good soil binding capacity. but care is needed as it spreads quickly and encroaches cultivated fields and it becomes difficult to eradicate it from fields.

6. **Tripsacum dactyloides: Common name: Guatemala grass**

Distribution: It is a native of tropical America and now distributed in Africa, Florida, Mexico, Brazil, and West Indies.

Climate: It is a species of hot climate and grows well in a range of about 1000-1500 mm annual rainfall. Soils: It is adapted to wide range of soils particularly moist, well drained, and fertile soils.

Cultural practices: In a well-prepared field the pasture is established through planting the seedlings and rooted slips in lines at about 1.0 m distance from row to row and 50 cm from plant to plant during rainy days.

Figure 35: Field photos of Tripsacum dactyloides

Management schedule: Grazing is best if deferred after 90 days at every two to three years, to enable plants to produce seeds. Due to tough midribs of the leaves, the cattle have difficulty in biting and more over the shallow rooted plants are easily up rooted. It makes very little growth in dry weather.

Forage yield: In first year it yielded 25 t/ha green forage without fertilizer, and this could be increased under good management (giving irrigation and fertilizers).

Utilization: It is palatable grass and provides a good fodder to all types of animals and is used as hay and is usually harvested at 10-20 cm height when the seed heads start appearing. This grass is extensively planted on rubber estates as a soil conditioner in drained swamps and for mulching. This is also used in soil conservation programmes

7. **Cenchrus ciliaris Common names: Buffel/African foxtail grass**

Distribution: The Buffel grass is an inhabitant of dry sandy areas throughout Africa, Madagascar and eastwards to Burma and Ceylon.

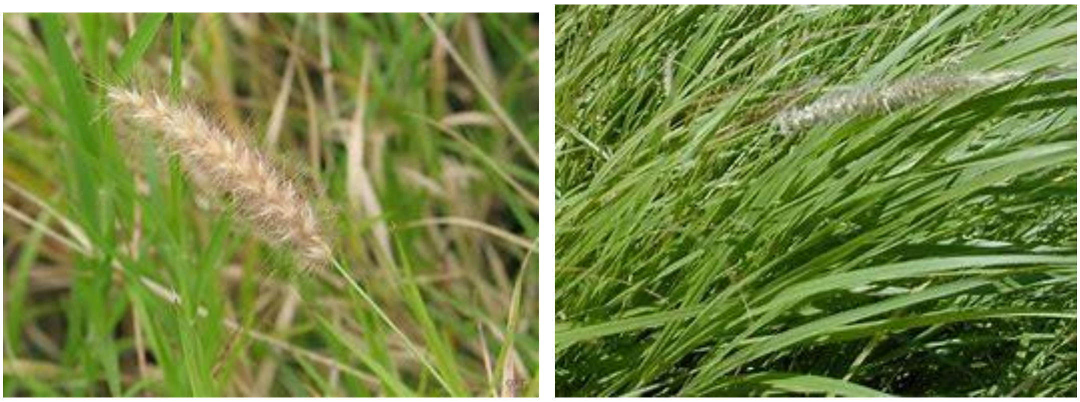


Figure 36: Field photos of Cenchrus ciliaris

Climate: It grows well in rainfall zones ranging between 125 to 1250mm in arid and semi-arid regions of the country. It can withstand drought and can also grow very well under irrigation.

Soils: It comes up best on well drained, light to medium textured soils which is red in colour and calcareous in nature. Its establishment on heavier soils (clay or lateritic) is not successful especially on soils deficient in lime.

Cultural practices: In well levelled land the sowing is to be done in lines using 4 or 5 kg seeds/ha after first shower in rainy season. Six weeks old seedlings/rooted slips can also be transplanted in a drizzly day at 50 cm row spacing and 30 cm plant to plant. Thus about 33,000 seedlings or rooted slips are required for one hectare area with 2 seedlings at each spot

Fertilizer: In the first year a basal application of 5 tons of Farm Yard Manure (FYM) along with 40 kg N and 20 kg P_20/ha is to be mixed thoroughly in the soil at land preparation. Afterwards 20 kg N/ha is top-dressed at one month crop stage. However, in subsequent years 40 kg N + 20 kg P_20/ha needs to be top dressed. For higher tonnage another dose of 20 kg N/ha may be applied after the first harvest.

Management Schedule: In the first year of establishment only one cut is to be taken in mid-October. From first year onward this grass gives 3-4 cuts and more can be had if irrigation is available. The first cutting should be taken at 60 days interval and subsequent cuttings after 30-45 days intervals depending on the rainfall. Cutting height may be kept 5-10 cm from ground level to ensure good regrowth in following years. The pasture is more productive during 2nd to 4th year, afterwards for its sustained production the pasture should be burnt moderately or ploughed.

Forage yield: Depending on rainfall the yield varies greatly and in arid tract with less than 300 mm rainfall a well-established pasture produces 9.0 to 11.0 t/ha green matter

Seed yield: For seed production75 cm spacing is advocated from line to line in order to avoid overcrowding through self-seeding. A well-established pasture yields around 125 kg seeds/ha

Grass-legume mixture: For quality forage after every two rows of grass spaced at 50 cm, one row of legume viz., Siratro or Caribbean stylo could be planted. For this, the legumes to be sown first at 1.5 m interval and then the grass seedlings are transplanted after the legumes have germinated. Such practice minimises the competition between the legume and grass seedlings for establishment and growth.

Nutritive value: The grass is relished by all classes of livestock. It contains 11.0per cent C.P. at young stage with suitable ratio of Ca and P.

Utilization: The grass is mostly used as cut and carry fodder but also well suited to grazing. This provides very good hay since it retains its nutritive value even when ripe fully. For silage, the grass should be harvested at flowering or seeding stage.

8. **Brachiaria brizantha Common names: Congo signal grass**

Distribution: Originally belongs to East Africa

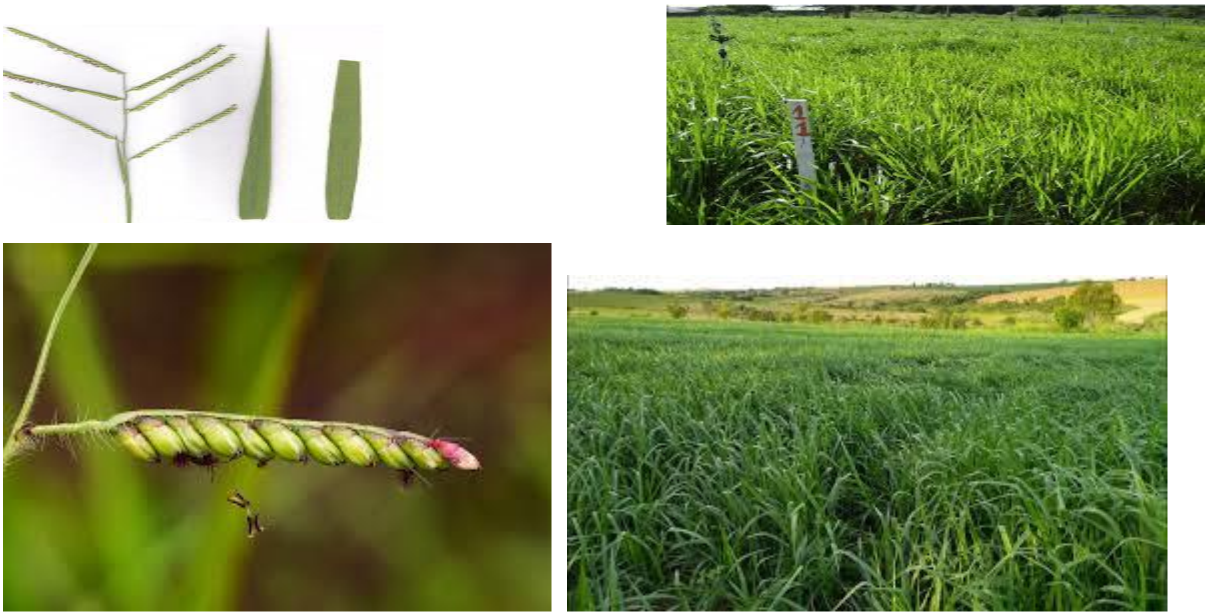


Figure 37: Field photos of Brachiaria brizantha

Climate: It requires warm and humid climate.

Soils: This grass thrives well on loamy soils.

Cultural Practices: In a well prepared, fertilized and level land small, rooted slips with 2-3 nodes are transplanted. The pasture can also be established by direct seedlings in lines at 30 cm apart at the onset of rainy season in dryland

Management schedule: It can be heavily grazed if used as a monospecific sward and regularly fertilized with nitrogen. If grown with legumes, the grazing system must favour the legume and adequate phosphorus must be maintained.

Fertilizer application & forage Yield: It responds well to fertilizer application

Nutritive value: It is used for hay making for lean period. It contains 9.6 and 8.1 per cent C.P. in July and October respectively.

Utilization: The grass remains green for major part of the year even under the rainfed conditions. It is much relished and is quite palatable.

HERBACEOUS LEGUMES

The major types of herbaceous legumes

1. **Stylosanthes guianensis Common names: Stylo**

Distribution: It is a native of Brazil, introduced in West Indies, Africa, India, and Pacific Islands.

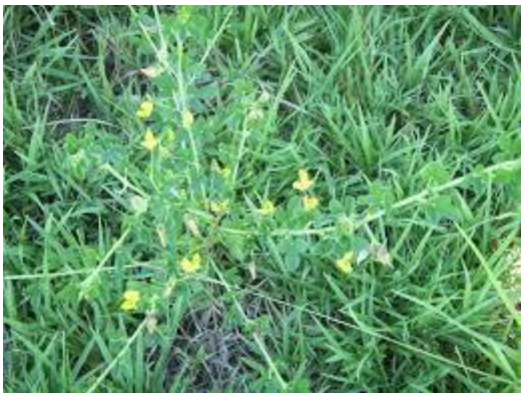
 

Figure 38: Field photos of Stylosanthes guianensis

Climate: It is suited to a warm humid climate with a temperature range of 15 to 29°C and withstands up to 43°C. It prefers an area, receiving a total annual rainfall in excess of 1525 mm. However, the Cultivar oxley is suited to lower rainfall (625 to 875 mm) conditions.

Soils: It grows well on a wide range of soils from coarse sand to sandy loams but not so well on heavy clays. It is not tolerant to salinity.

Cultural practices: For a better establishment the field should be well prepared and made free from weeds. At the commencement of rains inoculated seeds are drilled at 1 to 1.5 cm depth or broadcasted at a seed rate of 3.5 to 5.0 kg/ha. Stylo can be established even on less/lightly prepared fields by broadcasting the seeds. After sowing, the seeds are covered by dragging a twig over the areas. It may be established in natural grasslands, even by planting the cuttings at a distance of 1 to 2 m during the rainy days. At each spot 3-5 cutting, having at least 3 nodes, should be buried inside the moist soil. In natural grasslands over seeding is quite successful particularly on sandy soils in areas of adequate rainfall.

Fertilizer application: Stylo is efficient in extracting phosphorus as well as calcium from soils and is often not fertilized but it responds well to super phosphate. At the time of its establishment about 5 to 8 t/ha FYM should be mixed thoroughly in the soil along with 20 kg N + 30 to 40 kg P_20/ha. From second year the application of 30 kg P_20/ha is sufficient. Lack

Dolichos: The Hyacinth Bean, also known as Lablab

2. **Centrosema pubescens Common name: Centro**

Distribution: It is a native legume of tropical South America but found in most of the tropical countries of the world such as South-East Asia, Indonesia, Africa, and Pacific Islands.

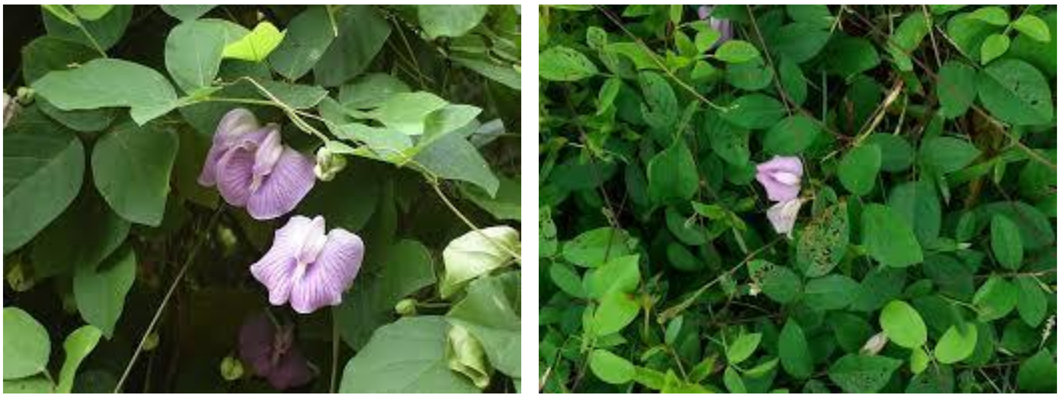


Figure 39: Field photos of Centrosema pubescens

Climate: It is found in hot humid climate where the annual rainfall exceeds more than 1525 mm.

Soils: It thrives well in alluvial to medium fertile soils and is moderately tolerant to poor drainage.

Cultural practices: One deep ploughing followed by cross harrowings, and planking are enough to prepare a good seed bed. Centro is sown in lines after first heavy rains in July. For pure stand the seed rate is 4-5 kg/ha but for mixed pasture the seed rate varies from 1.5 to 2.5 kg/ha. The seeds are hard and require hot water treatment for 30 minutes. After this seed inoculation should be carried .out for sowing. These are sown at 2.5 to 5.0 cm depth. It takes about four months for establishment, but once established it keeps on growing and needs little attention later on

Fertilizer application: Along with normal fertilizer, additional dose of phosphorus is beneficial as it responds well to super phosphate and trace elements.

Management schedule: In first year only one cutting is taken in the month of November while in subsequent years 2-3 cuttings are obtained depending upon the rainfall and its distribution.
Forage yield: It ranges from 15 to 20 t/ha (green).

Seed yield: It ranges from 100 to 150 kg/ha. Nutritive value: The C.P. content of the species varies from 1?, to 15 per cent in winter and reaches up to 23% in summer. It has high mineral contents.

Utilization: It is mainly used as cover crop in plantations and utilized as fodder crop. Older plants fix nitrogen effectively, increases soil nitrogen levels and the crude protein of associated grasses. Being deep rooted it is drought and flood tolerant.

Compatibility: It is successfully grown in mixture with grasses like Panicum, Pennisetum, Digitaria, Brachiaria, Setaria etc. Centro/guinea grass pastures have maintained a good balance over a period of 20-25 years.

3. **Neonotonia wightii Common name: Glycine**

Distribution: It is native to Kenya and other African countries and spread over Ethiopia and tropical Asia.

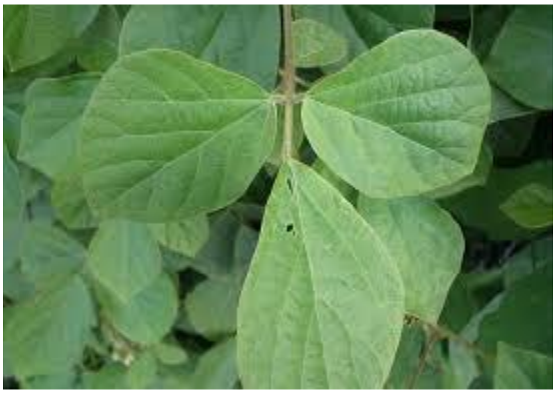



Figure 40: Field photos of Neonotonia wightii

Climate: It requires an annual rainfall of 760 to 1525mm.

Soils: It prefers fertile, heavy black soils with good drainage. It does not tolerate water logging and high acidity conditions. It tolerates soil pH up to 6.5.

Cultural practices: The glycine seeds should be sown in well prepared fields by broadcast during rainy season or in lines at 1-2cm depth and with 4-6 kg/ha seed rate. In case of line sowing the distance of line to line should be 50 cm to 1 m.

Fertilizer application: In first year 40 to 50 kg P_20_5 20 to 25 kg Potash and 15-20 kg N/ha are applied while from second year only 40 kg P_20/ha is sufficient.

Forage yield: The forage yield depends on soil type and climatic condition. It produces 50 t green forage in one hectare while dry matter yield varies from 8 to 10 t/ha.

Seed yield: In rainfed condition, the seed yield is 330 kg/ha while only 110kg/ha seed yield was found after one cut. Under irrigated conditions it gave 500-750 kg/ha.

Nutritive value: The average C.P. content ranges from 16.2 to 20.4 per cent in whole plant while it was 26.5 per cent in leaf.

Utilization: It tolerates lenient grazing in first year and provides good feed to livestock

Compatibility: Rhodes, green panic, guinea, and molasses grass are suitable companion grasses.

4. **Macroptilium atropurpureum. Common name: Siratro**

Distribution: The species is native to central and south America and is now distributed to Africa, Australia, South East Asia, and Pacific Islands.

Figure 41: Field photos of Macroptilium atropurpureum.

Distribution: The species is native to central and south America and is now distributed to Africa, Australia, South East Asia, and Pacific Islands.

Climate: It is adapted to sub-tropical to tropical climates and is found in areas of 615 to 1800mm rainfall and 26.5 to 30°C temperature.

Soils: Siratro thrives well on wide range of soils from light textured sandy soils to heavy clays with good drainage. It grows over a range of pH from 4.5 to 8.0 and even in moderately saline soils.

Cultural practices: For natural grassland or already established pasture seed should be sown after interculturing at the onset of rains. For pure pasture seed rate is 12 kg/ha but for mixed it is 6 kg/ha. Seeds are sown in July after first heavy shower either in line at 50cm space or broadcast. Sowing depth is 1.0 to 1.5 cm.

Fertilizer application: In beginning 10 cart loads of FYM is thoroughly mixed in soil followed by 10 kg N and 30 kg P_20/ha. In subsequent years 30 kg P_20_5/ha is broadcasted at the onset of rainy season. On fertile soils, no fertilizer will be necessary for a number of years.

Forage and seed yield: The average green fodder yield ranges from 15 to 20 t/ha and dry fodder from 3 to 5 t/ha. It produces the seeds two times in a year i.e. October-November and April-May The total seed production is 50-100 kg/ha.

Nutritive value: It gives high yields of palatable protein rich fodder with 16.8 per cent C.P., 33.4 per cent crude fiber and 9.8 per cent ash.

Compatibility: It fixes nitrogen very effectively and can be grown with a wide range of grasses such as Rhodes, Setaria, green panic and guinea grass.

Utilization: It is utilized as hay and for grazing purpose and is persistent under heavy grazing when the plants are well established. It is also used for silage. Due to heavy and fast leaf fall it helps in improving the soil and used for checking the soil erosion.

5. **Desmodium intortum: Common name: Green leaf desmodium**

Distribution: It is native of Central and South America and widely distributed throughout the tropical and sub-tropical regions of Africa, and Australia

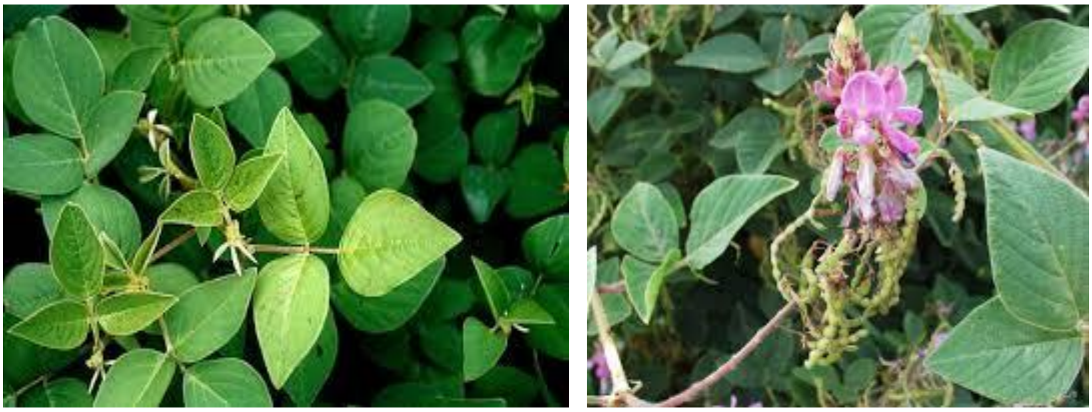


Figure 41: Field photos of Desmodium intortum

Climate: It is best suited to sub-tropical coastal areas with an annual rainfall of 900 to 1275 mm and requires a long warm growing season.

Soils: It grows on a wide range of soils from light to clay loams with neutral to moderately acidic in reaction and is well adapted to poorly drained or water-logged conditions. It has no tolerance to salinity.

Cultural practices: Because of its small seed size, it requires well prepared field and can be established by drilling or broadcasting using 2.2 kg seeds/ha at 1 cm depth. It can be established even by cuttings, although the establishment is only 30 to 40 per cent but when these cuttings are rooted in banana fiber baskets under light shade, the results are good. These cuttings are transplanted at 1x1 m spacing.

Fertilizer application: It usually requires adequate levels of phosphorus (40-50 kg/ha) sulphur (15-20 kg/ha), potash (20-25 kg/ha) and Molybdenum for growth.

Management schedule: In first year the pasture should be grazed moderately thus leaving a large number of axillary buds for ensuring rapid regrowth.

Forage yield: green forage yield is around 19 t/ha while average dry matter yield ranges from 5.8 to 12.5 t/ha depending upon the stage of the crop.

Seed yield: 80 to 100 kg/ha.

Nutritive value: It contains 13.1 per cent C.P., 0.34 per cent P and 1.44 per cent Ca.

Utilization: In addition to fodder value, it builds up a good surface layer of organic matter which adds to the moisture holding capacity and fertility of sandy soils. It contributes large quantity of N to soil too.

Compatibility: It competes strongly with weeds and associates well with a number of grasses including Setaria, green panic, molasses' grasses. Among legumes it grows well with siratro and glycine.

FODDER CROPS

Fodder crops are high yielding, high quality crops grown specifically for providing feed in intensive livestock grazing systems. These fodder crops are to be cut-and-carried to the animals. The technology of fodder crops and their use has had a very good impact with both zero-grazers and open-grazers

Fodder crops are important because:

- They provide a large quantity of high quality and palatable fodder within a short time.
- They are acceptable to the farmer (already adopted).
- They are easy to grow; the husbandry requirements are similar to other crops that are familiar to the farmer.
- They provide a way of introducing farmers to the concept of improved livestock nutrition.

Common fodder crops

a. **Pennisetum purpureum: Elephant grass**

This is the most popular fodder grass in Uganda. Elephant grass is best adapted for planting in well drained fertile soils. It is very drought resistant and can be used as a dry season reserve in all areas.

Establishment

A well-prepared seedbed (not fine) without weeds like couch grass is required. If farmyard manure is available, it should be worked into the soil before planting.

Figure 42: Field photos of Pennisetum purpureum)

Planting: is by using whole canes, cane cuttings or rooted shoots. The cane planting material should be obtained from plants about to flower. The stems should be green and disease free.

Planting should be done during the rainy season. Canes having 3 to 4 inter-nodes should be inserted in the soil leaving one inter-node uncovered. Whole canes should be put in furrows of about 4cm deep and covered with soil.

Row planting is recommended with widths of 1 to 2m between rows and 0.5 to 1m between plants. The spacing can be varied to suit different levels of soil fertility and rainfall. With poor soils and dry conditions, the spacing should be wider, and narrower with rich soils in wet conditions.

Varieties

A number of superior varieties are currently in use. These are KW_4 and P.99. These varieties are leafier, hairless, higher yielding than the local variety. The planting material can be obtained from Namulonge Agricultural and Animal Research Institute or the Makerere University Farm, Kabanyolo.

Management

Cutting is best done when plants are 1 to 1.5m tall. The cutting height should be 2 to 5cm above the ground. A first cut is possible 8 to 10 weeks after planting. Depending on the soil fertility and moisture, a cutting interval of 8 to 12 weeks is recommended.

After cutting, all weeds should be removed, and cow dung manure applied in furrows between the rows of elephant grass. This will ensure improved and prolonged productivity of the elephant grass.

Fertilizers: Elephant grass is highly sensitive to soil fertility conditions and will respond well where farmyard manure or nitrogen fertilizer is applied. NPK (nitrogen, phosphorous and potassium) fertilizers can be applied at the rate of 100 to 200 kg/ha. Calcium Ammonium Nitrate (CAN) and Urea fertilizers can also be used. However, these fertilizers are not readily available and are very expensive.

Farmyard manure is the cheapest option for majority of the farmers. The slurry (cow dung and urine) should be applied after each daily cut. If, however, only the dung is available, this should be put into small furrows dug along the elephant grass rows and covered with soil.

Weeding and inter-row cultivation: Weeding is essential during the establishment of the crop and later on during growth. This will maintain the grass vigour and productivity. It is a good practice to weed after each cut. Weeds stunt the growth of elephant grass.

Intercropping with legumes: Vigorous forage legumes are recommended for planting between rows. Examples are silver-leaf desmodium, Centro, and siratro. The legumes improve the feeding value of the elephant grass, control weeds, increase herbage production and improve soil fertility. A seed rate of 1 to 4 kg/ha should be used, and planting should be near the grass rows.

Diseases

Two diseases have been observed on cultivated elephant grass.

Stunting disease: This is a viral disease spread by insects. Part or the entire grass stool becomes stunted, pale green, has very many branches and eventually dies. The disease can be transmitted through the planting material. Planting material should be selected from healthy plants, and any stunted plants should be uprooted and burnt.

White spot: This is a fungal disease that appears on leaves of vigorously growing plants, particularly in wet conditions. The disease has no significant effect on yield.

Feeding management

Elephant grass is best used as a cut-and-carry feed. Grazing elephant grass or any of the other fodders, will lead to their early death.

The cut elephant grass should be chopped using a panga or a forage chopper. This minimises wastage and optimizes the amount that the animal can eat. A dairy animal weighing 250 to 300 kg should be fed on 50 to 70 kg of chopped elephant grass daily. One acre of well-established and managed elephant grass can support one cow and one calf.

b. Seteria sphacelata: Giant Setaria

Giant Setaria has become a very important fodder crop. It was introduced from Tanzania through the District of Masaka and has now spread all over the country. It has a dual purpose of providing feed for livestock and stabilizing soil and water control structures in banana and other crop gardens.

Giant Setaria is palatable, establishes well from vegetative material and produces high yields of high-quality feed. Giant Setaria grows well on a wide range of soils and is adapted to different climatic conditions

Establishment

This fodder grass requires a well-prepared seedbed. In Uganda, it has been successfully established through rooted cuttings

The spacing used on soil bunds is 50 cm between plants and 50 cm between rows. Where a pure stand of giant Setaria is to be established, closer planting of 30x30 cm is recommended.

Management

Giant Setaria should be cut at a height of 15 cm from the ground at a cutting interval of 6 weeks.

Fertilizers: Giant Setaria responds well to farmyard manure. However, being a grass, it would give increased output if nitrogen fertilizer were used.

Weeding: Weeding is important during the establishment phase. When established, Setaria suppresses most weeds. Weeds do not pose much of a problem to the grass in Uganda because it is grown with crops that need weeding. The value given to this crop by farmers who use it means that it is kept weed-free even when it is in a pure stand.

Intercropping with legumes: This is practised in Uganda. Giant Setaria combines well with glycine, greenleaf and silver-leaf desmodium and siratro.

Pests and diseases

General pests such as armyworms and locusts (these attack all pastures) do pause a threat. A fungal leaf spot attacks Setaria but with no obvious reduction in yield.

Feeding management

Like elephant grass, giant Setaria is used as a cut-and-carry feed. Chopping of the grass reduces on wastage.

c. **Lablab purpureus: Lablab**

Lablab is a very popular fodder crop with all livestock farmers, Lablab is easy to establish, produces a lot of herbage which when fed to animals improves their productivity and can be cut several times.

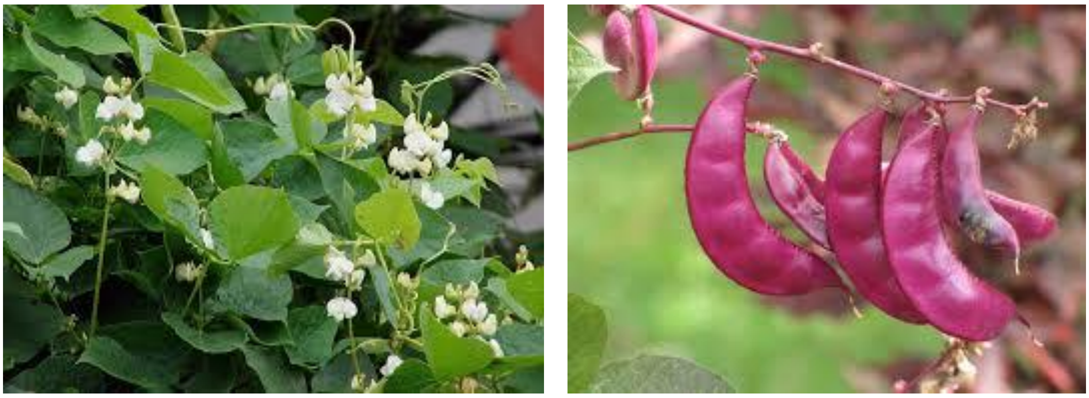


Figure 43: Field photos of Lablab purpureus

Varieties

Two varieties are grown in Uganda, Highworth and Rongai. Highworth has purple flowers and black seeds. It produces little herbage that is fibrous. Rongai has white flowers and white and brown seeds. It produces a lot of highly palatable herbage; therefore, it's high level of adoption as a fodder crop.

Establishment

Lablab is sown at a spacing of 1x1 m at a sowing depth of 2.5 cm and a seed rate of 10 to 30kg/ha. Two to three seeds are sown per hole. An application of phosphorous fertilizer at 50 kg/ha is necessary to improve the establishment of lablab. Lablab establishes slowly and so weeding must be done frequently.

Management

Lablab should be cut at the beginning of flowering in order to harness its optimum feeding value. The cuts that follow give forage with more stems than leaf, hence a lower feed value (low protein content). The best cutting height is 30 cm above the ground and should be above the branches to allow a re-growth. When properly cut, it is possible to harvest three times a year.

Feeding management

Lablab forage produces off-flavours in milk when fed fresh to milking animals. Wilting the forage or drying it before feeding will take care of this.

d. Medicago sativa: Lucerne

Lucerne is grown for cut-and-carry systems and for haymaking. Lucerne can also be grazed but animals should only be allowed to graze for a short time of about 2 hours before going out to the pasture.

Establishment

A well-prepared seedbed is essential. Planting should be with seed in continuous rows 30 cm apart at a seed rate of 5 to 7 kg/ha. Where irrigation is possible, the seed rate can be increased to 11 to 16 kg/ha.

On new fields, Lucerne should be inoculated to enable it fix nitrogen. If an old Lucerne field is being used, inoculation is not necessary.

Management

The first cut is done as Lucerne begins to flower at 15 cm above the ground. The cutting frequency can be 3 to 4 months.

Fertilizers: Single super phosphate (SSP) fertilizer should be applied to the field before planting at a rate of 100 kg/ha. Fertilizer should be applied at least once a year.

Weeding: Lucerne should be kept weed free until a full canopy is developed.

Pests and diseases

There are no obvious pests and diseases for Lucerne in Uganda. This could be attributed to the fact that it is not yet widely used in any one area. In Australia, aphids and root-rot were reported leading to breeding of a resistant variety.

Feeding management

The most common method of feeding Lucerne is as a cut-and-carry feed. In the 1960's, Lucerne hay used to be made at Mobuku Irrigation Scheme in Kasese. Lucerne makes good quality hay, and this could be done elsewhere.

e. **Sorghum bicolor: Sorghum**

Description: Forage sorghum is adapted to a wide range of environments, able to perform better than most crops under extreme climatic conditions, from excessive dry spells to excessively moist conditions, and under varied temperatures and soil types. It has the potential to supply quality feeds to ruminants in the dry highlands.

Ecology: Sorghum does well in low- to mid-altitude areas with 750-2500 mm of rainfall It tolerates conditions of limited moisture and produces a lot of feed during long periods of drought. It can be grown under wide range of soils, and it can be ratooned (harvested and left to grow again

Agronomy of Establishment: Plant at the onset of rain and intercropping should be done with an appropriate cover crop. Sorghum requires finely prepared seed bed like that for finger millet to ensure even germination.

- ❖ Prepare seed bed before onset of rains
- ❖ Plant at the start of the rains

- ❖ Use 10-14 kg of sorghum seed per acre
- ❖ Mix sorghum seed with one bag of TSP or DAP fertiliser and drill at a spacing of 30-40 cm from row to row or broadcast.

Weed control: whenever weeds appear

- Top-dress with one bag of CAN per acre after thinning to stimulate growth
- Control common pests such as shootfly and stem borer with insecticides (Duduthrin) 3 weeks after germination.
- Ensure all weeds are controlled timely and through rotation with legumes.
- Harvesting and storage: Sorghum matures 3 to 4 months after planting.

Sorghums are harvested for forage at start of flowering to avoid prussic acid poisoning.

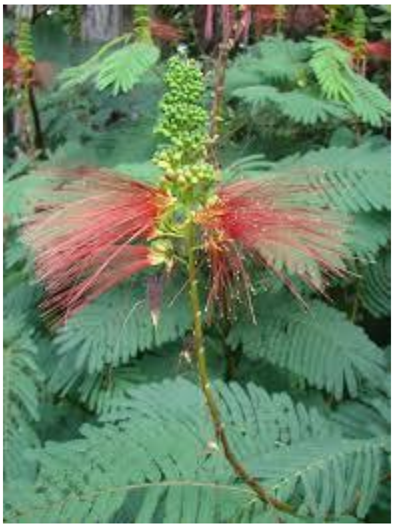
Production potential/ Feeding value

Under good management sorghums can give high forage dry matter yields of 5-7 tonnes per acre.

FODDER TREES

1. **Calliandra calothyrsus: Calliandra**

Calliandra calothyrsus (calliandra) is the most widely adopted exotic fodder shrub in East Africa. It's use as fodder in the region started in the Central Highlands of Kenya but has now spread to the other countries in the region, including Uganda, Tanzania, and Rwanda. It is a popular species for small-scale agroforestry in many parts of the tropics.



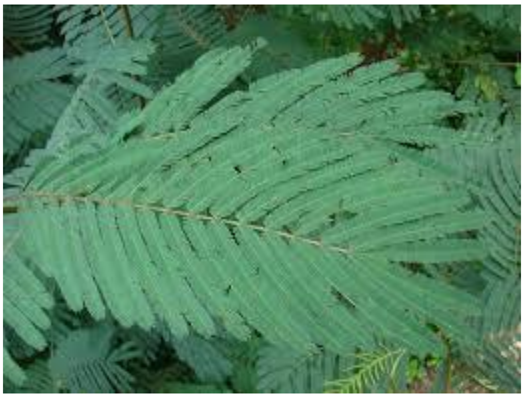


Figure 44: Field photos of calliandra shrub

Its advantages include

- Ease of establishment and management
- Fast growth
- Tolerance of acidic soils tolerance of repeated cutting
- Ability to fix atmospheric nitrogen.

Its disadvantages are:

- Low seed production
- Only partial shade tolerance
- High levels of tannins, which make its digestibility relatively low and limit its Usefulness for feeding non-ruminants.

Uses

Wood: The main use of calliandra wood is as fuel, because it grows very quickly, coppices well and produces small diameter stems and branches. The wood is quite dense, burns well, and can also be used to produce charcoal. The stems are generally of poor form, and this limits the use of calliandra poles in light construction. However, in some parts of the region (particularly Rwanda and SW Uganda) small diameter wood is used as supports for climbing beans, and in some areas, this is seen as its most important use.

Fodder: Animal fodder is the most important product of calliandra in East Africa. The leaves are excellent source of supplementary protein in the diet of cattle, goats, and sheep

Other uses: If not required for fodder, calliandra leaves can be used as mulch or green manure on other crops, to add nitrogen to the soil (because of its nitrogen-fixing ability). The nectar from the flowers is attractive to bees and they visit the flowers in the morning to collect the nectar left after nocturnal flowering. The honey is of very good quality and has a tangy flavour. Because of its showy red flowers, calliandra is also quite widely used as an ornamental tree

Land use, environmental and service aspects: Hedgerows of calliandra have been planted across sloping land to reduce soil erosion and improve soil fertility. It can also be used to improve fallow agricultural fields and degraded land.

Climate and soils

Climate: Calliandra is native to both the seasonally dry and humid tropics of Mexico and Central America. It can tolerate 2-4 months of drought, but it grows best in higher rainfall areas with a short dry season. It is not frost tolerant, though it grows in areas of the East African highlands where night-time temperatures can be as low as 3°C.

Soil: Calliandra occurs naturally on a wide range of soils in its native range, and so does well in a variety of soils wherever it has been introduced. One of its main features of interest to agroforesters is its tolerance of acid soils (e.g. alluvial deposits, clays, and sandy loams). Although it performs worse on acid than on neutral soils, it is more acid-tolerant than most other fodder shrubs. It grows in environments ranging from flat river banks to steep slopes (where it has been used in soil stabilisation projects). It does not tolerate waterlogging, soils with poor drainage, or soils which are regularly flooded.

Propagation & establishment

Propagation of calliandra can be by seedlings raised in a nursery, wildings collected from under a seed tree, or direct seeding.

Management

Calliandra seedlings usually grow slowly initially. It is important to keep the area around the young plants free of weed competition over the first 12 months. Calliandra can tolerate medium shade, even though it grows best in an open situation. The most important attribute of calliandra, with regard to its management in agroforestry systems, is its ability to tolerate repeated cutting (and also browsing at ground level), and to regenerate rapidly

Harvesting

Cutting, ideally with secateurs (for a clean cut), but commonly done using a panga, is the preferred harvesting method. Direct browsing is possible but not recommended, because:

- The wood is fairly brittle, and branches may be broken during browsing, unless the trees are cut at ground level and allowed to resprout.
- If the animals chew the bark from the trunks, the trees may die.

Harvesting can start 9-12 months after planting. The ideal cutting height is 50-100 cm (1.5-3 ft), and should not be lower than 30cm above ground, although cutting frequency (normally 6-12 weeks) is more important than cutting height to ensure maximum productivity. Leaves can be harvested every six weeks on fertile soils, during the rainy season. In drier weather and/or on poorer sites, the harvesting interval should be increased to 12 weeks or more. Normally 4-6 harvests per year can be expected.

Fodder productivity when grown in double rows in several African countries ranges from 0.8 to 8.2 kg of dry matter/m of hedge, depending on the soil fertility and the climate. Cutting six months before the height of the dry season gives maximum yield during that season. Although calliandra can be coppiced for up to 20 years, vigour declines with age and plants should normally be replaced after about 12 years

Feeding

Goats readily consume calliandra, but cattle may need an adjustment period when it is first introduced to their diet. In general, ruminants (cows, goats, and sheep) are more able than non-ruminants (pigs, horses, chickens, rabbits) to digest calliandra. This is because of the large amount of tannin in the leaves, which can be toxic to non-ruminants if fed in large amounts. Rabbits and chickens can eat calliandra in small quantities as part of a mixed diet (maximum 5% of the diet). It also produces a good yellow colour in egg yolks, although bigger quantities will reduce the number of eggs produced per chicken.

It used to be thought that calliandra should be fed fresh, but it has now been shown to give very similar effects whether fed fresh or dry. Because of its high protein content, it should comprise no more than 30% of the feed ration, to give a balanced diet. Fodder shrubs can be used either to supplement or to substitute for commercial concentrates. In the case of calliandra, it has been shown that kg of concentrates can be successfully replaced by 3 kg of fresh calliandra in the diet of dairy cows.

2. **Gliricidia sepium: Gliricidia**

Gliricidia is native to seasonally dry parts of Mexico and Central America, but it has been planted in other areas for several hundred years and is now naturalised in most parts of the tropics. It is a true multipurpose tree, with several important uses in addition to fodder.

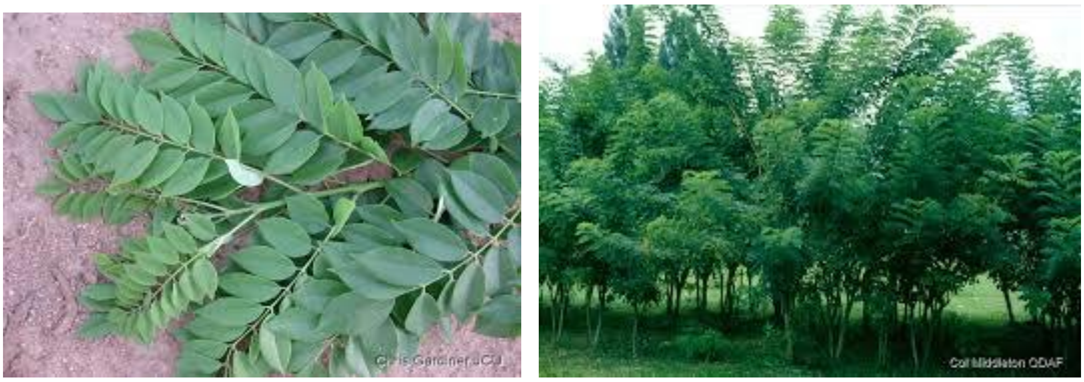


Figure 45: Field photos of Gliricidia sepium

The species name sepium is from the Latin for hedge: it is very widely used as a live fence because of its ability to sprout easily from stakes. It fixes nitrogen and is a preferred species for improved fallows. It is also widely used as a shade tree for perennial crops.

Gliricidia is a very good quality fodder for ruminants, although there are palatability problems in some areas.

Uses

Fodder: The fodder quality of gliricidia for ruminants is excellent, with a high protein content (18-30%), high digestibility (60-65% in vitro) and low levels of fibre and tannin. As a result, it has a clear positive effect on production in ruminants. Coumarin, an anti-nutritive factor found in the roots, bark, and leaves, is toxic to non-ruminants, so animals such as pigs, horses, rabbits, and poultry should be given only small amounts (less than 10% of the diet)

For ruminants, the problem with gliricidia as a fodder is its palatability, which seems to vary in different parts of the world.

Wood

If gliricidia is allowed to grow into a tree, it produces useful timber which is very hard, long-lasting, and resistant to termites. The wood has light brown sapwood and dark brown heartwood. It can be used for railway sleepers, construction, furniture, and tools.

Gliricidia prunings are widely used for firewood and charcoal production. The wood is slow to season, but once dried it burns slowly without sparks and with little smoke.

Other uses

- Gliricidia flowers attract honey bees, so it is good species for honey production.
- The leaves are a good green manure as they are high in nitrogen and break down rapidly in the soil.

Land use, environmental and service aspects: Gliricidia is widely used in many parts of the tropics for live fences, made by rooting large stakes as the fenceposts and stringing wire between them.

- When managed as a close-spaced hedge for fodder, it can also contribute to erosion control when planted along the contour

- It is an important component of improved fallows, owing to its fast growth and ability to fix (accumulate) nitrogen from the air
- It provides good light shade for perennial crops such as coffee and tea.

Climate and soils

Gliricidia does not grow well on cool sites. Mean annual temperatures below 15°C leads to leaf fall and poor growth, while temperatures close to freezing cause dieback.

Management

Newly-established seedlings need protection from browsing animals, weed competition and fire (though larger gliricidia plants are moderately fire-tolerant). Gliricidia tolerates repeated pruning and cutting between 0.3 m and 1.5 m above the ground stimulates leaf production. It can therefore be easily managed as a hedge. In dry areas, where unmanaged gliricidia trees lose their leaves in the dry season, the leaves are retained on resprouts. This means that regular cutting increases the value of gliricidia as a dry season fodder

Harvesting

Harvesting can start 8-12 months after planting. In areas where moisture is not limiting, pruning every 6-12 weeks is recommended, to give a high proportion of leaf relative to wood. During the dry season, cutting should be less frequent. Gliricidia can produce up to 20 tons of leaf dry matter per year.

Feeding

Gliricidia is usually fed to ruminants as a high protein supplement, making up 20-40% of the total diet. There are many reports of increases in weight gain and milk production in both large and small ruminants when it is used in this way

Animals need to become accustomed to gliricidia before they will eat it readily. The palatability is greatly increased by wilting the leaves for 12-24 hours before feeding them. Adding molasses or salt can also make the leaves more palatable

Pests & diseases

At present gliricidia has no serious pest and disease problems in East Africa. A potentially fatal disease called little leaf disease has been recorded in Central America but has not yet been found in Africa.

3. **Sesbania sesban: Sesbania**

Sesbania sesban ('sesbania') is a fast-growing, short-lived leguminous shrub or small tree. Although its geographical origin is not certain, it is widely distributed and cultivated throughout tropical Africa and Asia and has also been introduced into tropical America. It is found both in the humid tropics and in more arid and semi-arid regions. The greatest genetic diversity is found in Africa, so it probably originated there.

The most common use of sesbania is for fodder production. It is also often used as a short rotation tree on fallow and marginal lands, or in farming systems as a shade tree, a support tree for horticultural plants or in planted fallows. The leaves are also used as a green manure. The main disadvantage of sesbania is its short lifespan compared to other fodder shrubs. Its productivity starts to decline after about five years and the plants need replacing within ten years

Figure 46: Field photos of Sesbania sesban

Factors affecting the nutritional value of legume pastures

Three main factors affect the nutritive value of herbaceous legumes viz:

- Presence of secondary compounds produced by plants as a defensive mechanism: some of these compounds have anti-nutritional effects.
- The ratio of leaves to stems
- Content of nutrients, particularly soluble sugars, proteins, and minerals: legumes with higher nutrient contents are consumed to greater extent than those with lower levels.

UNIT II: PASTURE AGRONOMY

General considerations for pasture establishment

- Purpose of forage production: whether the forage will be used for grazing, feed lot or hay
- Choice of forage species: forage species that are best suited for the area
- Resources available in terms of equipment, money, and time
- Soil testing to correct soil nutrient deficiencies
- Implementing the correct seed planting method and seed rate
- Implementing a weed control program

Pasture establishment conditions

- Pasture grasses and legumes are very small seeded and so require a good and firm seedbed.
- To ensure that seeds receive enough moisture, enough oxygen and favorable temperature, sowing should be done after about three good rains.
- Fertilizers, particularly, phosphate-based fertilizers will give high production. A rate of 150 kg/ha is recommended.
- Well-composed organic manure could also be applied to the seedbed before planting. The use of fertilizers will however depend on location.
- Provide Fencing and paddocking, to help in the control of livestock grazing

Advantages of permanent grass-legume pastures:

❖ They produce high yielding, high quality pasture.

❖ The legumes improve soil fertility.

❖ They allow a high stocking rate

❖ Able to support high levels of animal production.

Agronomic practices in pasture establishment

i. Selection of pasture species

The success of any pasture depends on good choice by the farmer at the beginning of establishment process. This is because there are some variations within and between pasture species. Therefore, the specie chosen should have the following characteristics:

- Should be easy to establish
- Should have high dry matter yield
- Should be of high quality in terms of crude protein content
- Should not be expensive
- Should not be dangerous to the environment
- Should be easily eradicated when the need arises
- Should be acceptable to livestock

Seed quality

Seed quality is defined as the proportion of seeds that will germinate to form healthy plants.

To get good germination;

- collect and plant good, viable seeds.
- Select seeds that are whole; avoid damaged, diseased, and rotten seeds.
- Avoid poor quality seed as they lead to poor and prolonged pasture establishment.
- Seed germination and contamination with weeds should be checked.
- Seeds should not be stored for too long; they should be planted as soon as possible to ensure a high germination rate.
- Good pasture seed should have a germination percentage of about 30% for grasses and at least 70% for legumes.

ii. Land Preparation

Good seed to soil contact is essential to maintain adequate moisture near the seeds. This moisture is necessary for germination and secondary root growth. Land preparation is highly dependent on the type of machinery that is available/affordable or whether it's a new pasture or renovation.

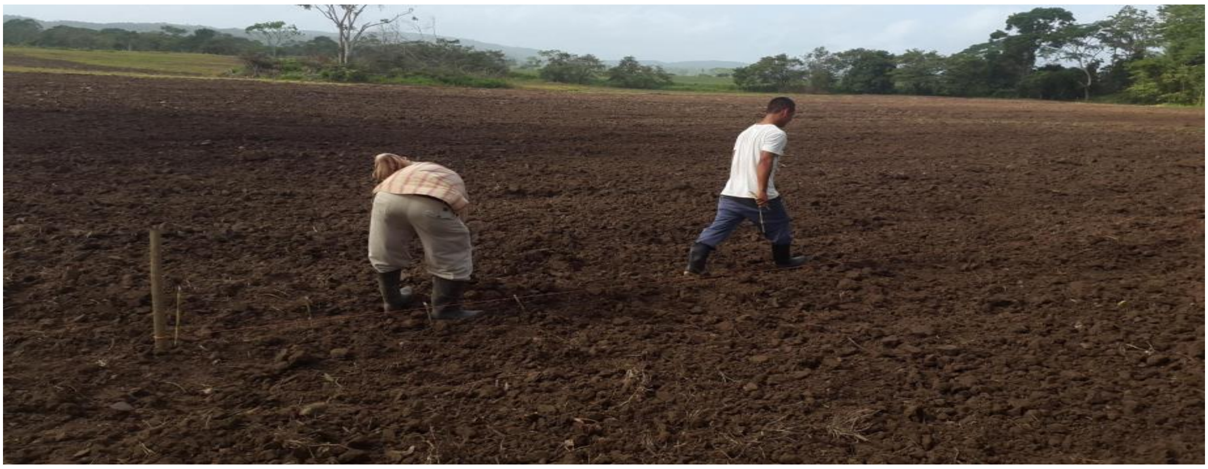


Figure 47: Land prepared for seeding

Land preparation for reseeding or pasture establishment is very critical for the success of sward establishment. The timing and siting of reseeding areas should be well done. Pasture establishment under rainfed systems requires timing where land preparation and planting are done on time before the rains. This is even more serious considerations in the arid environments where planting should be done early to capitalize on the first rains.

Benefits of land preparation to seed establishment:

• Loosen the soil surface

• Reduces the rate of runoff hence controls soil erosion

• Enables better infiltration of rain water into the soil

• Eases the penetration of roots of the crop into the soil

• Prevents grass seed from being blown away by wind

• Removes all unwanted plants (weeds) so as to give the target crop a head

iii. Planting

- **Broadcast sowing**

This is done manually by hand under small scale production systems. However, we do have seed broadcasting machines where the land area is expansive, and the production system is mechanized. This can be tractor pulled equipment (broadcasters) that are calibrated to broad cast seeds at a known rate. Other modifications are use of fertilizer spreaders. Immediately after seed broadcasting, it should be lightly covered with soil. The easiest practice can be the use of tree branches pulled over the area broadcasted in small scale farms. While in the large, mechanized farms where erosion can occur, rollers are used.

Important to Note:

• Ensure uniform spreading of seeds on a prepared soil surface

• Avoid seed broadcasting on a windy day

• Avoid soils easily compacted by rain

• Avoid broadcasting during the hot and dry weather

• Due to the size of seeds, mix with an inert material e.g., sand or sawdust.

- **Drill sowing**

This method is most suited since the seeds are covered immediately after placement. However, the process is not suitable for many light grass seeds or hairy types like Cenchrus ciliaris since they will not flow well from the driller. There are methods to counter this, pasture seeds can be mixed with other foreign degradable material like saw dust or rice husks.

- **Vegetative propagation**

There are many grasses that are low seeders or produce unviable seeds such as Napier grass, kikuyu grass, Brachiaria spp and star grass. These species are mostly established vegetatively by use of stem or root cuttings or splits. When using cuttings, it is important to ensure at least 2-3 nodes are buried in soil.

Figure 48: vegetative propagation parts

- Make the cuttings from mature branches about 30 to 50 cm long, about the thickness of thumb. Cut at an angle of about 45^0 degrees to increase the surface and avoid water stagnation.
- Keep cuttings moist and transport them within hours for transplanting into a moist soil bed. Prepare and transport the cuttings to coincide with the start of the rains or when soil moisture is reliable. This method is cheaper and avoids the cost of purchasing seed or producing seedlings in a nursery.

iv. Correct seed rate

Is determined by factors such as:

- ❖ Seed size; the smaller the seed the lower the rate
- ❖ Germination potential
- ❖ Seed viability
- ❖ Seed purity
- ❖ Growth habit
- ❖ Method of sowing chosen
- ❖ Quality of seed bed preparation

Assignment: Explain each of the above points in your discussion groups

Table 4: Recommended seed rates for common pasture species

S/N	**Pasture**	**Seed rate**
1.	P. purpureum	7000cuttings/acre, With at least 2-3buds intact
2.	Desmodium sp	0.45 - 0.91kg/acre
3.	Panicum maximum	2.27- 4.55kg/acre
4.	Brachiaria sp	2.27- 4.55kg/acre
5.	Chloris gayana	6.82 - 13.64kg/acre
6.	Guatemala grass	5000 cuttings/acre
7.	Hyparrhenia rufa	6.82 - 13.64kg/acre
8.	Centrosema pubescens	1.36 -1.82kg /acre

9.	Cenchrus ciliaris	6.82 -13.64kg/acre
10.	Stylosanthes sp	0.91kg/acre
11.	Sorghum bulgarea	4.55kg/acre

v. Seed treatment

Most pasture legumes have hard seed coats that prevent permeability of water, for example seeds of stylo and centro

The seeds should be treated so that:

• Germination can be increased.

• Rhizobia bacteria inoculation to ensure the development of nitrogen fixing nodules.

Suitable pasture seed treatment methods include:

- **Hot water treatment**

• Soak the seed in warm water (40^0C) overnight.

• Dry in the shade in the morning before planting.

• Plant the seed and never store such seed.

- **Scarification**

Rub small quantities of seed between two sheets of sandpaper; or put the seed on a concrete floor and rub with sand-paper. This is often needed with seeds of stylo

- **Inoculation**

Some pasture legume seed require inoculation for proper nodulation. The appropriate inoculants should be supplied with the seed. Inoculated seed should be planted on the same day.

vi. Management of weeds in a pasture

A weed is a plant out of place not intentionally sown; whose undesirable qualities outweigh its good points. Some desired plants species may be weeds when growing in unwanted places. Weed management in established pastures is very critical for good pasture sward. Weeds are known to bring competition both for nutrients, light, space, and water. This may result to reduced productivity and even the final quality of the products. Some weeds are invasive and may end outcompeting the planted pasture species a result of inter-specific competition. However, not all weeds are bad to animals; some are actually very nutritious especially when they are leguminous. Others could be conferring benefits to the established swards such as nitrogen fixation.

As a pasture manager, one needs to understand the botanical composition of the swards and weigh the negative or positive impacts before clearing. Some weeds could also be of negative contribution to sward productivity or quality but still important for soil erosion control, biodiversity contribution e.g., nesting place or cover for wildlife. Weeds could be a challenge in many ways such as: -

- Allelopathic properties making other species not to grow
- Alternative hosts for pests and diseases
- Shading other plants among others

The weeds can be annuals, biennials, or perennials. Some weeds could be grasses, forbs, or legumes. Knowledge of weed science in pasture management is critical especially when producing pasture seeds for the market.

vii. Fertilizer application

Fertilizers are needed in pastures for better establishment and quality. This is due to the supply of necessary nutrients (macro and micro) that are highly essential for pasture growth. Lack of these nutrients in the soil can lead to poor growth and performance of pasture species. Different pasture species have different fertilizer requirements. For example, grass species require more of nitrogenous fertilizers than phosphorus, although phosphorus is also critical to the survival of the species. Legumes need more of phosphorus and calcium rather than nitrogen.

There are two types of fertilizers used in pasture management. These include: -organic fertilizers or farm yard manure and chemical fertilizers. All of these fertilizer sources supply the same type of nutrients to pastures. However, the rate of release of these nutrients differed between the fertilizer sources. Organic manures are very slow in the release of nutrients compared to chemical fertilizers. Chemical fertilizers are further categorized into straight (e.g., Urea 46%N) and compound fertilizers (e.g., NPK 15:15:15) depending on the number of chemicals they contain.

- **Methods of application of fertilizers to pasture**

Special Fertilizers can be applied to pastures either during land preparation or at planting. Phosphatic fertilizers such as Single Super Phosphate (SSP) can be applied at single dose during land preparation because it is immobile in the soil. However, nitrogenous fertilizers such as urea can be applied in split doses to capture the highly mobile nitrogen in the soil. Therefore, it is advisable to apply nitrogenous fertilizers to pastures at 3 and 6 weeks after planting for better results. Fertilizers are mainly applied using broadcasting method, but they can also be drilled. However, spot application is only possible in pasture species such as forage maize.

Also, depending on soil conditions, it may be necessary to do soil analysis to supply the limiting nutrient. Mostly, N is the limiting factor, and more so, when doing pasture seed production due to the cut and carry fodder – mining the nutrients. The timing of fertilization needs be done when wet season sets in to allow utilization, and also at the right stage of plant growth, mostly at vegetative stage.

viii. Pests and disease control:

Pests like grasshoppers, termites, rats, mice among others may also be a challenge in pasture production. Birds have also been a challenge when looking forward to producing seeds, and this may need bird scares during seed setting until harvest.

Grass/pasture diseases also do occur, even though not much has been done on the same, but treatment for fungal and bacterial diseases could be necessary. Legume pastures can be managed with care for diseases and agro-input stores and pasture scientists can provide solutions.

ix. **Pasture harvesting:** The pasture harvesting should also be done at the right timing depending on management objectives, if for high yields, then harvest should be done before seeding to have high CP.

PRACTICAL METHODS OF IMPROVING NATURAL PASTURES

i. Fencing

Fencing is important for:

- ❖ Excluding non-farm animals' access to the pastures.
- ❖ Controlling grazing.
- ❖ Allowing for paddocks hence rotational grazing.
- ❖ Helping farmer to implement pasture improvement techniques.
- ❖ Protection of fodder banks.

ii. Bush and weed control

Bushes and weeds reduce grass productivity while some are poisonous. Food reserves in the root systems are exhausted by frequent uprooting and slashing, leading to their stunted growth and eventually death.

Hoes, pangas, or slashers are very useful tools for this activity. The hoe, in particular, is a good tool because its action on the soil ensures sustainable soil management. Uprooting and slashing should be done, preferably, before the plants begin to shed seed.

iii. Provision of water

In the open grazing system, water should be evenly distributed on the farm to avoid overgrazing and soil erosion around the watering point. Where only one watering point is available, paddocks should be constructed in such a way that animals can access the water while they are in any one paddock. In areas with water shortage, harvesting rainwater should be.

iv. Soil conservation

Soil erosion occurs in hilly areas of Mbarara, Kabale and Mbale Districts. The causes of soil erosion are rain, wind, patchy grazing, and overgrazing. This can be corrected by:

- ➢ Planting stoloniferous grasses like star or Kikuyu grass helps in soil conservation
- ➢ Construction of bunds along contour lines to control water run-off.
- ➢ Construction of terraces and planting them with fodder grasses/legumes.

v. Oversowing/Reseeding

Oversowing (the introduction of improved pasture species of grasses or legumes to a natural pasture) as a method of improving natural pastures requires minimum cultivation and little or no use of fertilizer

Oversowing increases forage quality and productivity of natural pastures. It is the simplest and cost-efficient pasture development strategy. Although both grasses and legumes could be used during oversowing, the most suitable are legumes. Grasses generally have poor germination and are slow to establish on compacted soils. Benefits of oversowing are evident after about two years.

MANAGEMENT OF IMPROVED NATURAL AND PERMANENT PASTURES

The reason for improving natural pastures or establishing permanent pastures is to provide feed of good quality for livestock throughout the year. The improved or established pastures will still have seasonal growth and production with periods of lush, high nutritive feed and periods of shortage and low nutritive feed. Therefore, good pasture management should include controlled use (grazing or cutting) and conservation strategies.

1. Controlled early grazing

- Grazing should not be allowed until the grasses and legumes are well established and have developed a strong root system.
- Uncontrolled early grazing may lead to plants being pulled out of the soil and the soil may be compacted by the livestock.
- The first grazing, which should be light, is done 2 to 3 months after the seed has germinated.
- Light grazing allows the grass to develop more shoots (tillering) so that the legumes are not shaded by the grass and grow well.

2. Efficient use of pasture

This refers to how many animals are allowed into a given area of pasture at any given time. This is the stocking rate.

- The stocking rate should be flexible such that the number of animals kept are increased or lowered to match pasture availability.

- Given the annual rainfall, the soil fertility and potential pasture productivity, for efficient use of pastures, a stocking rate of 1 tropical livestock unit (TLU) that is equivalent to a 250 kg bovine animal is recommended.
- High quality grass/legume pasture should not be allowed to become too mature.
- Grazing should not be lower than 20 to 30 cm high.
- Conservation (hay or silage) of excess pasture produced during the growing period, or the purchase of feed or sale of animals, will all lead to efficient use of pastures.

3. Weeding

- The pasture should be kept weed-free.
- Some weeds are poisonous. These include *Lantana camara* (tick berry or sage brush), *Solanum incanum* (Sodom's apple) and *Phytolaca dodecandra*.
- Weed control should be done using the panga and hoe. This is the cheapest option for most farmers.
- Continuous cutting of the plants and digging out of roots of all types of weeds will reduce their population and weaken the plants until they are eliminated.
- Weeding of pastures is a continuous activity to which a farmer should pay particular attention.
- Good grazing management will control weeds in a pasture.

4. Paddocking

- Fencing enables the farmer to control grazing.
- Paddock construction is the subdividing of the pasture area into portions. The recommended paddock size is 2.5 acres, but this can be varied depending on the land available and the number of animals on the farm.
- Paddocking enables rotational grazing. It is possible to limit the use of pastures to specific periods and particular animals.
- Rotational grazing ensures pasture re-growth and helps to maintain or improve the condition of the pasture.
- Graze any given paddock for a period of 1 to 2 weeks followed by a 4 to 8 week of rest period. This will result in optimum production of pasture breaks the life cycle of most internal parasites that may be present. The grazing and resting periods should be flexible depending on weather conditions.

UNIT III: FODDER CONSERVATION & PRESERVATION

The growth pattern of pastures and fodders changes according to the rainfall pattern. There are seasons of surplus feed for livestock and some of shortage. In principle, the surplus feed should be preserved for the season with a shortage. This is called fodder conservation. Fodder can be conserved as hay or silage.

Forages can be conserved to feed livestock during periods of shortage caused by limited pasture growth or inadequate pasture conditions or fed as a supplement. Conserved forages can take the form of hay, haylage, and silage. Although several methods have been proven as efficient ways to store and preserve forages, it is important, to keep this fact in mind: At best, conserved forages can rarely match the nutritive value of fresh forage because some losses of highly digestible nutrients (sugar, protein, and fat) are unavoidable during conservation and storage. Our goal in forage conservation is to focus on minimizing losses, which start immediately after cutting.

Reasons for fodder conservation:

- A constant supply of good quality fodder is essential to maintain maximum production from a herd.
- Animal feed supply is seasonal: Dry season feed shortage affect animal production levels and contribute to overgrazing hence exposing the soil to all agents of erosion.
- Store feed when there is surplus and feed it to the animals during shortage
- Avoiding losses to pasture: cut and make hay than to burn over-mature grass or let it rot

Hay making

This is a process whereby fodder is harvested at a time when the feeding value is high and conserved in a dehydrated form

Guidelines for haymaking

- Ideally a mixture of grasses and herbaceous legumes is desirable because legumes increase digestibility and intake of the conserved forage. Most grasses are good for hay production and are convenient for cutting.

- When making hay from legumes, after cutting there should be as little turning over as possible, because leaves of legumes easily break off easily (losses)
- The principle of hay making is that grass (DM 25%) is dried so much that it becomes hay (DM> 80%). Dry the cut pasture as quickly as possible.
- The best time to cut grass for hay is just before flowering in order to have high digestibility and high protein content.
- After cutting, the grass should be turned over and spread. Tedded to accelerate drying, baled and stored in a dry place.
- To minimize losses and weather risks, hay can be dried (DM 70%) and brought indoors and ventilated until it is dry.
- If too wet material is stored, respiration continues and produces water and heat which promotes rotting
- Continued respiration leads protein denaturation and feeding value declines
- Once dry, heap up the hay into a “stack” which should be protected from the rain. The use of a tarpaulin or polythene sheet is recommended.

Baling of hay makes storage easier.

This requires:

- A bottomless wooden box (baling box) with dimensions of 3ft by 2.5x2.5 ft.
- A 10 ft long sisal string.
- Dry pasture material.
- Have 3 to 4 people tightly pack the pasture into the box, tie it very tightly and remove the box to leave a bale.
- The bales of hay must be stored off the floor; kept moisture free and allow plenty of air circulation to prevent moulding.

Hay requirements

If hay is the only feed available, depending on its quality and excluding any wastage, the requirements will be as shown in Table below:

Table 5: Hay requirements for different ages of animals

Animal	Grass hay (kg/cow/day)	Legume hay (kg/cow/day)
Cow	7–13	3–5
Heifer	5–9	1–3
Young dairy stock	2–3	1

Source: National Agricultural Research Organisation (NARO)

Reasons for low hay production in tropical areas

- Tropical pasture species have thick stems which dry more slower than the leaves. This results in uneven drying: leaves become too dry and may break while stems do not dry enough
- Good hay making weather occurs at the end of the rainy season and at this time digestibility of the pasture is already low
- Lack of proper equipment

Hay making losses

- Losses of DM can be as high as 30%, due to respiration, leaching of soluble compounds, microbial breakdown, and mechanical losses
- Storage of hay with more than 20% of moisture leads to natural heating up caused by respiration, thermal bacterial and fermentation and increases the losses of dry matter, digestibility, and protein concentration

Qualities of good hay:

- Have a good proportion of leaves to stems.
- It should be green in color-yellow indicates bleaching, brown or black suggests mould.
- Developed flowers indicate that the grass was cut long after flowering. This hay usually is of poor quality.

SILAGE MAKING

Silage is the final product when forage of sufficient moisture (> ~50%) is conserved and stored anaerobically (oxygen-free), under conditions that encourage fermentation of sugars to organic acids. The acidity generated by the organic acids (mainly lactic acid, but also acetic and propionic acids) and the lack of oxygen prevent the development of spoilage microorganisms.

Three of the most critical factors for silage production are:

- Rapid removal of air,
- Rapid production of lactic acid that results in a quick lowering of the pH (this is the result of adequate fermentation processes), and
- Rapid feedout once the silo is opened and exposed to air to avoid heating and spoilage.

Ensiling is the process of silage making; while a silo is the container used. It may be a drum, trench, pit, or polythene bag.

Suitable crops for ensiling

All pasture and fodder crops can be ensiled. The most ideal would be maize and sorghum but these still form the bulk of human food in Uganda, hence cannot be used for that purpose.

High quality silage will be made if:

- Grasses are harvested when flowering.
- Legumes are harvested during pod filling.
- Maize/sorghum are harvested during milk-stage.

Improving silage quality

Pastures under tropical conditions (Uganda inclusive), particularly the grasses, have a low feeding value. The changes that take place during the process of ensiling reduce the value even further. The addition of either molasses, maize bran or cassava flour will improve the quality of the silage by increasing the energy content and also act as preservative.

The quantities can be adjusted to match the amount of fodder. Two parts of water should be added to one part of molasses to ease application; and a watering can would be a useful piece of equipment.

The process of ensiling

- ✓ Harvest the pasture or crop (material) for ensiling, a panga can be used.
- ✓ Chop up the material to 2 to 5 cm pieces that will ensure firm packing to exclude oxygen (air).
- ✓ Rapidly fill the silo to be used. The bag silo and air-tight drums are commonly used by small-scale farmers in Uganda and is recommended. Medium to large-scale farmers could use circular pit silos. The size of these is 1.5 m deep and 1.25 m in diameter. The capacity of this kind of a silo is 3 to 5 tons silage.
- ✓ Prevent the entry of air by covering the silo with a plastic sheet.
- ✓ Protect the silo from water by either covering completely with a polythene sheet over which a layer of soil is placed

The use of silage

- The silage is always ready to serve after 1 month period from the day of ensiling
- The silage made under proper storage conditions could be kept for a longer period.
- About 3 to 5 tons of silage is capable of feeding 2 to 3 crossbred cows for 66 days.
- Feed a little silage at a time until the animals are used to the feed;
- To avoid off-flavours in milk, feed silage to dairy animals after milking.

Table 6: Utilization of silage for different types of stock

Stock type	Quantity of silage (kg)
Milking cow	10–20
Dry cow	10–15
Dairy heifer	5–8
Beef breeding cows	12–20
Fattening calves	4–8

Source: NARO