



Fodder production Brief

Introduction

This brief has been developed as an introduction to Fodder Production in the Ethiopian Lowland context. The brief highlights the steps in the (1) establishment of native grasses for fodder and seed production and (2) the fodder production and native grass production from these established grasses. Thirdly an overview of grasses and legumes common to the African arid and semi-arid rangelands is presented, including a description, their ecological range, suitable soils and forage value & seed production.

The brief can be used together with the flipbook 'Fodder grasses and legumes for the lowland context' and the poster 'How to establish native grasses for fodder and seed production' as part of the Extension Package on Crop production.

Table of contents

Introduction.....	Page 1
Steps to establish native grasses for fodder and seed production.....	Page 2
Overview of the different perennial grasses native to African arid and semi-arid rangelands.....	Page 4

Steps to establish native grasses for fodder and seed production

- **Step 1:**
Selective bush clearing – Clearing the land of unwanted invasive species through a combination of different methods e.g. manual, mechanical, prescribed burning, high intensity browsing. Leave trees and bushes standing.
Why?: Reduce competition for the grass seedlings for e.g. nutrients, water. Eliminate invasive species. Prescribed burns releases nutrients held in plant biomass into soil
- **Step 2**
Seedbed preparation – Minimal soil disturbance (across slope) to break soil hardpan using e.g. ox-driven ploughs, (walking) tractor. Follow up with harrowing where necessary. Prepare the seedbed before the onset of the rains.
Why?: Loosen soil, facilitate the penetration of roots of established grasses to deeper soil layers, enhance rainwater infiltration and reduce runoff
- **Step 3**
In situ rainwater harvesting – Creation of micro-catchments and macro-catchments, half-moons (hoops), can be through the use of hand tools like a hoe (zabye).
Why?: Prolong soil moisture for grass establishment, reduce runoff and soil erosion, enhance rainwater infiltration, lowers soil temperature at root zone
- **Step 4**
Sowing native grass seeds – Dry planting, perennials, recommended seeding rates, e.g. 5-7.5 kg ha⁻¹, through furrow planting/broadcasting, cover seed with thin layer of soil (dragging Acacia branches), weed management
Why?: Native grasses are adapted, dry planting to take advantage of first rain, perennials for resilience, thin soil layer eases germination maximizes water use efficiency, soil cover protect seeds from birds, weeding to reduce competition

Fodder production and Native Grass production

Steps 1 – 4 enable the production of fodder and the production of native grass seeds:

A. Fodder Production

Harvest of biomass yields, 2-3 cuts before maturity per growing season (cut and carry), baling and storage. Livestock feed. Surplus hay can be sold and thus source of income. Biomass yields of up to 5000 kg ha⁻¹ annually



B. Native Grass Seed Production



Harvest of mature grass seeds (e.g. hand stripping or cutting with stalk) and store dried seeds (2-3 days) in dry place in e.g. gunnysack. Seed stock for next sowing season. Surplus seed harvested can also be sold and thus source of income. Seed up to 300 kg ha⁻¹ annually



Point of attention:


- The grass seeds should be planted very shallow or not covered at all. No more than 2 cm of soil to cover the seeds. Otherwise the grass seeds will not germinate.
- Use manure before planting and harrow this into the soil. Also apply manure after harvesting.
- The best planting season for grasses near the early rains. This will ensure that the young established grasses have a short period of drought before the summer rains. 2 seasons will provide a good basis for the grasses to establish well, after that they are more hardy to survive long periods of drought.
- Harvesting:
 - For fodder harvesting and hay preparation the grass is harvested at a younger stage, before it turns yellow or before flowering stage.
 - For collecting seeds: it takes about 3 months between planting of the grasses and for them to reach maturity for collecting seeds.


Overview of the different perennial grasses native to African arid and semi-arid rangelands


Grass species	Overview
<p><i>Cenchrus ciliaris</i></p> <p><u>Common names</u> African foxtail grass Buffel grass</p>  	<p>Description – Native to tropical and sub-tropical Africa. A tufted perennial, occasionally with short, stout rhizomes. It is widespread in African drylands and is highly valued for reseeding, because of its outstanding drought tolerance, persistence and good forage value. The numerous varieties differ considerably in vigor and leafiness, and care in the selection of good types is essential (local varieties desirable). Reliable varieties seeders are “Biloela”, “Mbalambala” and “Kongwa 531 “. Seeds disperse profusely by clinging to animal fur. Seeds are light with barbed bristles and may disperse by wind as well. Can grow up to 120 cm, with deep fibrous root system of up to 200 cm.</p> <p>Ecological range – wide ecological and climatic range occurring in very arid (<350 mm), arid (300-550 mm) and semi-arid (450-900 mm). It occurs in areas with average annual temperatures ranging between 12-28° C. Optimum temperatures for photosynthesis in varieties measured is 35° C and minimum between 5-16°C.</p> <p>Soils - occurs in the wild on sandy soils, but is also well adapted to deep, freely draining sandy loams, loams, clay loams and red earth soils. It requires good soil fertility, particularly with respect to Nitrogen, Phosphorus and Calcium. Phosphorus (P) levels should be > 10mg/kg and total Nitrogen (N) levels > 0.1%. The optimum soil reaction is pH 7-8, but grows on soils with pH as low as 5.5. It is very sensitive to high levels of soil Aluminium and Manganese. Apart from soil depth, rooting depth is also limited by high sub-soil salinity or sodicity and low pH of <5. However, it has a moderate tolerance of salinity.</p> <p>Forage value and seed production - It produces reasonable quality hay when cut in the early flowering stage, yielding up to 2 500 kg/ha per cut with a protein content of 6-10% of dry matter. Dry matter yields depend greatly on soil fertility and growing conditions but is mostly in the range of 2-9 tonnes/ha and under ideal conditions up to 24 tonnes/ha. Seed yield ranges between 10-60 kg/ha of clean seed per harvest. Easily established from seeds that can be picked in arid and semi-arid African rangelands.</p>


Grass species	Overview
<p data-bbox="204 600 475 633"><i>Eragrostis superba</i></p> <p data-bbox="204 674 424 703"><u>Common names</u></p> <p data-bbox="204 707 437 739">Maasai lovegrass</p> <p data-bbox="204 743 440 775">Wilman lovegrass</p>  	<p data-bbox="576 450 1394 936">Description – A tufted perennial, 20-120cm high, with leafy herbage, widespread in the semi-arid lands of Africa. The grass is very common in various vegetation types mainly grassland and savanna types throughout its distribution range. It also occurs in rocky and sandy grounds. <i>Eragrostis superba</i> grows in disturbed places and thus has been used successfully for reseeding denuded lands. It has also been used for reseeding denuded pastoral land in Africa because of its excellent establishment characteristics. <i>Eragrostis superba</i> and <i>Cenchrus ciliaris</i> have been the basis of seed mixtures for large-scale reseeding in African pastoral lands. It has a deep rooted system which go as far as 2.2m with 73% of the roots limited to the upper 0.4m from the soil surface, which enable the grass to make full use of light showers of rain.</p> <p data-bbox="576 976 1394 1111">Ecological range – Occurs in semi-arid African drylands particularly where mean annual rainfall is about 500-900mm. The grass occurs from 0-2000m above sea level and does not grow below -11°C.</p> <p data-bbox="576 1151 1394 1397">Soils - It can be grown in gravely, sandy, loamy or clay soils. However, it prefers sandy soils but occurs also on clay loams and clays. <i>Eragrostis superba</i> can also be found on termite mounds common in the arid and semi-arid land in Africa. A medium-textured deep soil neither strongly acid nor strongly alkaline is preferred. It has a high tolerance to salinity and alkalinity and the seed will germinate well.</p> <p data-bbox="576 1438 1394 1845">Forage value and seed production - Chemical and digestibility analyses indicate that the grass has 12% crude protein (%CP) in the dry matter at an early-flowering stage with 30-35% crude fibre (%CF). Pastoralists in Africa have identified <i>Eragrostis superba</i> as one of the grass species suitable for fattening and improving the condition of their livestock herd and increasing milk production. Seed can be collected easily from open grassland or at roadsides by stripping the ripe panicles. Mature spikelets are easily detached. The grass grows very easily from seed. Depending on the management, it can give high yields of more than 24000 kg ha⁻¹ per annually at 8-week cutting interval.</p>


Grass species	Overview
<p data-bbox="194 488 411 551"><i>Enteropogon macrostachyus</i></p> <p data-bbox="194 591 411 689"><u>Common names</u> Bush ryegrass Mopane grass</p>  	<p data-bbox="568 439 1378 855">Description – <i>Enteropogon macrostachyus</i> is a widely distributed African rangeland species very common in arid areas where it grows in bush, in forest edges and to a lesser extent in open grassland. It is particularly suitable for reseeding rock slopes or bushland. It has proved an excellent grass for reseeding African rangelands under moderately dry conditions. This grass species has been tried with moderate success for reseeding denuded pastoral land in Africa receiving annual rainfall of 550-800mm. <i>Enteropogon macrostachyus</i> is a good grass for arid and semi-arid ecosystems because it is drought resistant. This species has erected stems of 30-100cm high, with roots of up to 2 m deep.</p> <p data-bbox="568 896 1378 994">Ecological range – It occurs from 300-1600m above sea levels in semi-arid areas of tropical Africa. The species occurs in areas receiving around 575mm of rainfall per annum.</p> <p data-bbox="568 1034 1378 1173">Soils - It occurs naturally in grasslands and rocky outcrops in semi-arid African environments. It can be established in a wide range of soil types, but does well in loose sandy and loamy soils and alluvial silts.</p> <p data-bbox="568 1214 1378 1774">Forage value and seed production - Although stemmy, it is drought resistant and provides useful grazing for herbivores. It is palatable. Thus, its re-introduction in degenerated African pastoral lands is of obvious value to livestock. : Crude protein 7-14%, up to 16% at early flowering stage. It is highly palatable especially when young. Biomass yields of 10 t ha⁻¹ annually and up to 600 bales of hay weighing 15 kg annually. It is well grazed by livestock and is a valuable grass in semi-arid rangelands. Good seeding stands occur in <i>Acacia/Commiphora bushlands</i>. Seed production of up to 108 kg ha⁻¹. It is a very good seeder and seed can be collected rapidly by cutting the seed heads or stripping the heads by hand. The seeds germinate readily and grow vigorously. For seed quality and rapidity of germination, <i>Enteropogon macrostachyus</i> has no equal amongst the dryland grasses. It is an excellent grass for reseeding under moderately dry conditions.</p>



Grass species	Overview
<p data-bbox="209 524 422 560"><i>Chloris gayana</i></p> <p data-bbox="209 595 411 663"><u>Common name</u> Rhodes grass</p>  	<p data-bbox="577 360 1393 707">Description – <i>Chloris gayana</i> is a stoloniferous perennial grass species native to Africa. It has widely grown and naturalized throughout the tropics and subtropics because of its wide adaptability and ease of establishment. It is also a popular cultivated pasture species among pastoral communities in African because it is reported to withstand heavy livestock grazing. It has a vigorous root system reaching down to 4.7m confers making it reasonably drought resistance. <i>Chloris gayana</i> is an extremely variable species in morphology and agronomically important characteristics.</p> <p data-bbox="577 745 1393 882">Ecological range – In its natural range, <i>Chloris gayana</i> occurs in grasslands and open woodlands up to 2000m a.s.l., in areas with an annual precipitation from about 500–1500mm and average annual temperatures from about 17 °C to 37 °C.</p> <p data-bbox="577 920 1393 1167">Soils – Grows mostly on alluvial soils, but also on loose lava ash. While preferring well-structured loams and clays of volcanic origin, <i>Chloris gayana</i> grows on most well drained soils, except very heavy clays, provided fertility is adequate. Very tolerant to saline soils. More tolerant alkaline than acidic soils with low pH. Grows best in soils with pH of between 5.5 and 7.5. Tolerates waterlogged soils (up to 15 days).</p> <p data-bbox="577 1205 1393 1827">Forage value and seed production - <i>Chloris gayana</i> is a prolific seeder and the seeds are easy to handle. Seeds can be obtained in formal seed suppliers in Africa. Thus, there is a tendency to use Rhodes grass indiscriminately because of its ease of establishment. However, its use should properly be restricted to areas where it is known to persist, which will normally receive higher mean annual rainfall (>800 mm). For reseeding denuded pastoral land, the “Rongai” and “Boma” varieties are normally preferred because of biomass yields and are more drought and salinity tolerant than most other cultivated varieties. Biomass yields of between 10-16 tonnes DM ha⁻¹ and seed production of up to 173 kg ha⁻¹. Nutritive value of crude protein 8-10% DM and crude fibre 35-40%. <i>Chloris gayana</i> is often used to reseed pastoral grazing lands in Africa because of its ability to spread fast to cover the ground, tolerance to drought, light frost and its suitability for growing in association with many tropical legumes. <i>Chloris gayana</i> can be established vegetatively or by seed.</p>


Grass species	Overview
<p><i>Chloris roxburghiana</i></p> <p><u>Common names</u> Horsetail grass Plume chloris</p> 	<p>Description – A tufted perennial, 60-120 cm in height characterized by flat shoot bases and dense, feathery panicles that are pale green or purple when young. It is native to Africa, drought tolerant species and is widespread in arid and semi-arid rangelands in Africa. It is often a pioneer grass species in abandoned croplands or dry woodlands. <i>Chloris roxburghiana</i> occurs at 0-1500m above sea level in open and bushed grasslands.</p> <p>Ecological range – Major grass component in dry areas and has the widest ecological adaptation. Drought tolerant requiring 500-625 mm of rainfall.</p> <p>Soils – <i>Chloris roxburghiana</i> does well in loose sandy soils, loams and alluvial silts. Good for soil and water conservation.</p> <p>Forage value and seed production – <i>Chloris roxburghiana</i> has good nutritive value with up to 16% crude protein in the dry matter (DM) at the early-flowering stage. The crude fibre content at this phenological stage is about 30% of the DM. It is a prolific seeder. This species often forms pure stands from which seed can be collected in large quantities. The spikelets are not easily detached from the panicles (due to the matting of the long fine awns) and it is therefore convenient to cut the panicles and thresh the seed later. The seed is extremely difficult to handle. Each panicle contains about 1 000 seeds. The caryopses are small with a density of 6.5 to 13 million seeds per kg. <i>Chloris roxburghiana</i> has been successfully used for reseeding African drylands. However, it may not be suitable for reseeding at altitudes > 1200 m, because it is a grass of warmer climates. It is a highly palatable especially when young. The grass has also been observed to be highly palatable to cattle, sheep and goats and wild herbivores. Biomass yields of 9.9 tonnes ha⁻¹ annually, and up to 657 bales of hay weighing 15kg. Highly rated as a valuable forage species in African rangelands. <i>Chloris roxburghiana</i> can also be used as a garden ornamental.</p>


Grass species	Overview
<p><i>Panicum maximum</i></p> <p><u>Common names</u> Guinea grass Tanganyika grass Buffalo grass</p> 	<p>Description – <i>Panicum maximum</i> is an extremely variable grass species, loosely to densely tufted, shortly rhizomatous or erect. Due to its variability, the species is also commonly described as the short (S) (height < 1.5 m) or tall and medium (TM) type (height > 1.5 m). It is native to Africa and widely naturalized in the tropics. Grows naturally in open grasslands, usually under or near trees and shrubs (e.g. Acacias) and along riverbanks.</p> <p>Ecological range – Tall and medium (TM) varieties of <i>Panicum maximum</i> are mostly grown in areas with annual rainfall above 1000 mm, while the short (S) varieties are established in rangelands receiving 800 mm or less rainfall annually. Drought tolerance varies among cultivars, although generally they do not tolerate dry periods longer than 4-5 months. Tolerant of short term flooding by moving water e.g. riverbanks. Occurs in altitudes over 2000 m. Short varieties are generally less affected by cooler temperatures. The tall and medium varieties perform better at warmer altitudes, producing good early season growth.</p> <p>Soils – <i>Panicum maximum</i> grows in a wide range of soil types providing they are well-drained, moist and fertile. However, some varieties are tolerant of lower fertility and poorer drainage. Additionally, tolerance to acidic soils and high Aluminium (Al³⁺) saturation varies. Varieties such as “Vencedor” and “Centenário” were bred to withstand these conditions. The species is generally intolerant of waterlogging or salinity</p> <p>Forage value and seed production – <i>Panicum maximum</i> is of excellent grazing value. It is highly palatable and grazed by all classes of livestock, with particularly high intakes of young leafy biomass. Biomass yields commonly at 20-30 tonnes ha⁻¹ DM and up to 60 tonnes ha⁻¹ DM, depending on variety and growing conditions. Crude protein from 6-25% depending on phenological stage of the grass. Seasonally, in 12 week old regrowth, crude protein commonly range from 5-10%, P levels from 0.15-0.18%, Ca from 0.6-0.8% and Na from 0.07-0.12%. Seed is normally not worth collecting from wild stands, as in most types of <i>P. maximum</i> seed is only scarcely formed and most of the spikelets, often over 95%, are empty. Seeds are excessively palatable to birds and sheds very easily. As guinea grass is reasonably palatable, spread is minimal or slow under grazed conditions. It is very effective in colonizing in ungrazed rangelands, especially where minimal soil disturbance has occurred. Seed yields of 50-100 kg ha⁻¹ pure seed yield are common under machine harvesting and around 200 kg ha⁻¹ from ground sweeping.</p>


Grass species	Overview
<p data-bbox="199 589 534 618"><i>Pennisetum purpureum</i></p> <p data-bbox="199 658 419 687"><u>Common names</u></p> <p data-bbox="199 694 368 723">Napier grass</p> <p data-bbox="199 730 400 759">Elephant grass</p> <p data-bbox="199 766 373 795">Merker grass</p> <p data-bbox="199 801 368 831">Barner grass</p> 	<p data-bbox="571 315 1380 842">Description – <i>Pennisetum purpureum</i> is a very versatile tropical grass species, that can be grown under a wide range of environmental conditions (dry and wet) and systems. It originated from sub-Saharan tropical Africa and has been introduced as forage into most tropical and subtropical regions worldwide. It is one of the highest yielding tropical forage grasses and very popular throughout the tropics. Napier grass is a robust, rhizomatous, tufted perennial grass. Its root system is very vigorous formed at the nodes of its creeping stolons (horizontal stems above ground). Roots can penetrate to soil depths of 3 m and the stems are coarse reaching a height of up to 7 m. Ideal under cut-and-carry systems, silage and hay making for livestock stall-feeding mainly for milk production. Many cultivars of Napier grass have been developed globally to suit local conditions and wide range of habits and to enhance yield potential and nutritive value. Napier grass is very similar in appearance to sugarcane but has narrower leaves and taller stems. Napier grass is also a multipurpose grass species that can also be used as an ornamental, landscaping and as a windbreak.</p> <p data-bbox="571 882 1380 1066">Ecological range – Napier grass from sea level up to an altitude of 2000 m. It does well in places where temperatures range of between 25 °C and 40°C and where annual rainfall is over 1500 mm (high potential areas). However, it is also tolerant of drought and will grow in areas where the rainfall range is 200-4000 mm. It stops growing at temperatures below 15 °C and is very sensitive to frost conditions.</p> <p data-bbox="571 1106 1380 1350">Soils – <i>Pennisetum purpureum</i> is intolerant to flooding and prefers well-drained soils. In poorly drained soils, it establishes best on raised seedbeds. Prefers rich, deep soils, such as friable loams, but can grow on poorly drained clays, with a fairly heavy texture, or excessively drained sandy soils with pH ranging from 4.5 to 8.2. Napier grass does well full sunlight conditions. However, it can still produce good yields under partial shade but not complete shading under a dense tree canopies.</p> <p data-bbox="571 1391 1380 1886">Forage value and seed production – <i>Pennisetum purpureum</i> produces very few seeds. Thus, it is mainly propagated vegetatively through stem cuttings (at least 3 nodes) 2 of which are buried in rows. Row width of 50-200 cm and distance within rows of 50-100 cm is recommended. Napier grass can reach height of 4 m, 3 months after planting. Biomass yields are highly dependent on prevailing climatic conditions, especially temperature and rainfall. Under high input fertilization, annual yields range is 20-80 tonnes DM ha⁻¹ and 2-10 tonnes DM ha⁻¹ under rainfed agriculture with minimal or no fertilization. Depending on the location and season, cuttings can be made at intervals of 45-90 day. On average it has crude protein of 11% dry matter (DM) and crude fibre of 36% DM. Mineral composition of calcium 3 g kg⁻¹ DM, phosphorus 2.5 g kg⁻¹ DM, potassium 27 g kg⁻¹ DM and magnesium 2 g kg⁻¹ DM. Its high moisture content in stems makes it prone to termite attacks during dry season, especially in dryland environments.</p>

Grass species	Overview
<p data-bbox="212 696 549 730"><i>Sorghum × drummondii</i></p> <p data-bbox="212 768 414 835"><u>Common name</u> Sudangrass</p> 	<p data-bbox="584 315 1388 674">Description – Sudangrass is a tall annual forage grass species native to Africa (Sudan and Egypt). It has erect fine slender stems (3-9mm thick) and narrow leaves. It can reach a height of up to 3 m. It has an exceptional tillering capacity and thus fast and excellent regrowth after livestock grazing or cutting. It is one of the quickest source of forage in tropical Africa especially as a pasture, because of its high digestibility. It can provide quick cover to prevent weeds and soil erosion. Sudangrass is recommended for either free-range grazing or forage conservation (hay and silage). It is capable of withstanding hot and dry environments, thus producing high quantities of biomass yields. It is also preferred as a filler for forage or cover crop primarily to avoid soil erosion, suppress weed, prevent plant diseases and replenish soil organic matter in croplands.</p> <p data-bbox="584 712 1388 1010">Ecological range – It grows well in typical semi-arid and dry sub-humid regions where annual rainfall ranges from 600 to 900 mm and temperatures are between 7 and 27°C. Sudangrass does not tolerate frost. In cold conditions the species becomes dormant. However, it will resume growth when the prevailing weather become favourable. It is drought resistant. Sudangrass is cultivated and naturalized widely in the United States, but is most common in the southern states e.g. New Mexico, Texas, Arizona. It is now also widespread in Russia, Thailand, Philippines, South America, Australia, South Africa, Central and Northern Europe.</p> <p data-bbox="584 1077 1388 1227">Soils – Sudangrass is tolerant of a large range of soils, from heavy clay to sandy soils. It can withstand slightly alkaline and saline soils. It does not withstand waterlogging and frost. Sudangrass can tolerate alkaline soils (pH 9) and often used in rotation with cereal crops to reclaim alkaline soil. Sudangrass can tolerate soil pH as low as 5.0.</p> <p data-bbox="584 1265 1388 1742">Forage value and seed production – Average yields are 80 tonnes ha⁻¹ (fresh weight), 12-15 tonnes ha⁻¹ (dry weight) and 40-45 tonnes ha⁻¹ (feed conservation e.g. silage). Its exceptional tillering capacity and fast regrowth makes it possible to have 4 harvests during the growing season. Sorghum hybrid varieties are known to produce prussic acid poisoning in livestock. Grazing poses the most risk to livestock when the plants are young (up to 50 cm tall) and drought stressed. Thus recommended to graze or ‘cut-and-carry’ only when forage is greater than 50 cm tall. Depending on the phenological stage of development e.g. vegetative, seed setting, and soil type, crude protein content ranges between 8-17%. Highly palatable species (juiciness and sweetness) and nutritious forage, few insect attacks and disease problems, does not require herbicides and have high carrying capacity especially when rotationally grazed. Little waste occurs even when fed as hay. Seed production of up to 1500 kg ha⁻¹ under rainfed conditions. Seeding technique should allow uniform seed distribution, proper seed depth, and good seed-to-soil contact.</p>

Grass species	Overview
<p data-bbox="204 591 405 624"><i>Cajanus cajan</i></p> <p data-bbox="204 663 405 692"><u>Common name</u></p> <p data-bbox="204 696 352 725">Pigeon pea</p> <p data-bbox="204 732 349 761">Congo pea</p>  	<p data-bbox="576 315 1382 465">Description – Pigeon pea is a short-lived leguminous perennial (1-5 years) shrub, usually grown as an annual, 0.5-4 m high. It has many slender branches and stems up to 15 cm in diameter. Roots are thin roots up to 2 m deep. Fruit type is a pod (5 cm long) with numerous seeds (up to 6).</p> <p data-bbox="576 506 1382 757">Ecological range – <i>Cajanus cajan</i> is largely domesticated and not found naturally in the wild. Its natural habitat conditions remain uncertain. Pigeon peas prefer grassy habitats in warm tropical zones with optimum 600-1000 mm annual rainfall. However, it can also be cultivated in humid areas with 2500 mm annual rainfall and in semi-arid areas with only 400 mm of rain annually. Occurs within an altitude range of 0-2000 m with mean annual temperature 18-38 °C and mean annual rainfall of 400-2500 mm.</p> <p data-bbox="576 797 1382 1016">Soils – <i>Cajanus cajan</i> can be planted in a wide range of soils with variable physical and chemical characteristics. However, it grows well in alluvial soils because these soils require least water due to their high porosity. Pigeon pea is cultivated on Vertisols and Alfisols, with pH from 5 to 7 or more. It is sensitive to high salt concentration in soils (intolerance) and thus poor yields are expected in saline soils. It is also susceptible to waterlogging conditions.</p> <p data-bbox="576 1057 1382 1845">Multipurpose benefits – <i>Cajanus cajan</i> seeds can be used as a vegetable. Fresh seeds contain vitamins, especially vitamin A and vitamin B complex. Dry seeds contain up to 10 g water, 30 g protein, 9 g fat, 65 g carbohydrates, 10 g fibre and 4 g ash per 100 g edible portion. The energy content averages 1450 kJ per 100 g seeds. Pigeon peas leaves can be used for livestock feed formulations, instead of alfalfa. Pods can be used as livestock feed but are low in protein and high in fibre content. High fibre content make the pods a good source of roughage for livestock. Dry pigeon pea grain is used as poultry feed. Its yellow and red flowers are a rich source of bee forage/nectar producing a distinctive greenish colored honey. Multiple branches as good source of fuel and timber used for light construction e.g. roofing and making baskets. Extensive coverage of croplands with <i>Cajanus cajan</i> prevents soil erosion by wind (windbreak) and water. Long-term <i>Cajanus cajan</i> crop stands can fix up to 200 kg N ha⁻¹ over a 10-month period, through biological nitrogen fixation (BNF). Its vigorous root system (2 m) can break soil hardpans, thus improving soil structure, enhancing rainwater infiltration and reducing runoff and sediment production (sheet erosion). Green manure through leaf fall builds soil organic matter and provides additional nitrogen. <i>Cajanus cajan</i> appears to possess special mechanisms that enables it to extract phosphorus from Vertisol (black cotton soils) common in African dryland environments. <i>Cajanus cajan</i> is a non-competitive with cereals crops e.g. maize and wheat, and thus ideal for intercropping.</p>

Grass species	Overview
<p data-bbox="169 680 424 714"><i>Vigna unguiculata</i></p> <p data-bbox="169 752 371 786"><u>Common name</u></p> <p data-bbox="169 790 280 824">Cowpea</p> 	<p data-bbox="536 304 1350 904">Description – Cowpea is often referred to as the ‘poor man’s meat’ as it is a significant source of protein, minerals, and vitamins for the rural poor who have limited access to animal protein (meat and fish). Cowpea is a drought tolerant versatile multi-purpose annual legume grown directly from seed and cultivated throughout the tropics and sub-tropics (Africa, Latin America, Southeast Asia and United States) for human consumption, soil improvement and livestock fodder provision. In Africa, cowpea is mainly grown for its grain because of its ability to tolerate dry spells and drought. Cowpea has a spreading to fairly erect habit, with varieties growing between 50 and 100 cm high. The stems are hollow with no hairless with a main stem of about 1 cm thick. The trailing and twining stems much thinner. The fruit is a pod, grey to orange in colour when ripe and 10 - 20 cm long and 1 cm diameter. Seeds are diversely coloured ranging from e.g. black, grey, orange, brown and cream. Cowpea is very susceptible to insect (bean flies, heliothis, aphids, leaf bugs and flower thrips) damage, especially at seedling stage often causing death of plants. Cowpea has a strong taproot system (reaching soil depth of 1.5m) and many spreading lateral roots in the upper soil layers.</p> <p data-bbox="536 943 1350 1227">Ecological range – Cowpea is a drought-tolerant legume crop, well adapted to a diverse range of climate. Cowpea does well in warmer temperatures ranging between 25 and 35 °C. Annual rainfall amounts of 750-1100 mm are optimal for maximum biomass production for forage and/or soil cover. Less amount of rainfall of up to 500 mm is sufficient for early-maturing varieties. Cowpea can also grow in environments receiving up to about 2000 mm annually. However, such high rainfall amounts increase the incidence of fungal diseases such as fusarium wilt, powdery mildew, charcoal rot and sclerotinia.</p> <p data-bbox="536 1265 1350 1485">Soils – Cowpea is also adapted to a wide range of soil and moisture conditions. It is tolerant to poor and sandy soils that tend to be less restrictive on root growth. However, it grows best in well-drained sandy loam to clay loam soils with a pH of 6-7. It does not tolerate frost or waterlogged and poorly drained soils. Generally, very fertile soils do not require soil amendments e.g. fertilization. However, molybdenum may be necessary on acidic soils and zinc alkaline soils.</p> <p data-bbox="536 1523 1350 1807">Forage value and seed production – Cowpea is highly palatable and of high nutritive value to livestock (crude protein in green foliage 14-21%, crop residues 6-8% and grain 18 - 26%). Cowpea can produce leafy biomass of up to 5 tonnes of hay per hectare ha in 3 months and seed grain of up to 1000 kg ha⁻¹. Seeds weigh 5 to 30 g per 100 seeds. Best time to harvest cowpea for hay is at peak flowering (2-3 months) after sowing. In good seasons, cowpea forage will regrow after grazing. However, light grazing is recommended to maintain the plant structure frame and minimize damage to the crop.</p>

Grass species	Overview
<p data-bbox="194 651 454 685"><i>Cynodon dactylon</i></p> <p data-bbox="194 723 411 860"><u>Common names</u> Bermuda grass Couch grass Star grass</p> 	<p data-bbox="568 327 1378 770">Description – Bermuda grass is a major tropical perennial grass species widely spread in all tropical and subtropical areas. It is hardy species and extremely valuable for native and established pastures because it exhibits high tolerance drought and heavy grazing by livestock. Bermuda grass can also be established for cut-and-carry system, hay and deferred feed for stall feeding livestock. Many varieties and hybrids have been developed for different cultivation conditions. <i>Cynodon dactylon</i> is a stoloniferous and rhizomatous grass species that forms dense leafy mats that can reach up to 40 cm high. The creeping horizontal stems (stolons) can spread rapidly reaching a length of up to 20 m, but are generally much shorter around 2m. Underground biomass is mostly rhizomatous and densely rooted at the nodes. Majority of the root system is concentrated in the upper 25 cm depth but can go as deep as 1 m in sandy soils.</p> <p data-bbox="568 808 1378 1252">Ecological range – Bermuda grass occurs naturally in open grasslands and semi-natural pastures. It easily colonizes uncultivated areas e.g. roadsides, sand dunes, riverbanks and abandoned livestock corrals in pastoral areas. It also grows well on overgrazed and landscapes trampled by livestock. It persists in a wide average annual temperatures range of between 6 and 28°C, but performs best within daily temperatures range of 17-35°C. It is intolerant to cooler temperatures and ceases to grow at temperatures below 15°C. Bermuda grass grows well in areas receiving annual rainfall of between 625 and 1750 mm annual rainfall, but can tolerate lower (550 mm) and high (4300 mm) rainfall, making it very versatile. Its robust and deep underground rhizome makes it tolerant to dry (up to 7 months drought) and flooding (few weeks submerged in water) conditions. This makes it resilient to environmental perturbations.</p> <p data-bbox="568 1290 1378 1603">Soils – Bermuda grass grows best in fertile, deep and well-drained soils. However, it is easily adaptable to a wide range of soil types including those occurring in marginal areas with less fertility. Bermuda grass naturally occurs in soils with pH range of between 4.3 and 8.4 (optimum at > 5.5) and has some tolerance to salinity but not Al³⁺ thus a suitable species to establish in coastal areas and under irrigation. Bermuda grass is shade intolerant and may die under medium to dense canopy shading. Its strong rhizomatous development helps in binding soil on bare ground thus commonly introduced to rehabilitate and restore denuded pastures.</p> <p data-bbox="568 1641 1378 1861">Forage value and seed production – Bermuda grass is of moderate nutritive value. However, it is a valuable forage species because it is one of the most grazing-resistant tropical grasses and can withstand heavy livestock grazing once established. Dry matter yields of the grass are about 5-15 tonnes ha⁻¹. Bermuda grass has fine stems and leafy biomass making it a suitable species for making good quality hay, with crude protein of up to 16%.</p>

Grass species	Overview
<p data-bbox="210 562 434 629"><i>Dactyloctenium aegypticum</i></p> <p data-bbox="210 667 432 696"><u>Common names</u></p> <p data-bbox="210 703 528 732">Egyptian crowfoot grass</p> <p data-bbox="210 739 411 768">Crowfoot grass</p> <p data-bbox="210 775 456 804">Finger comb grass</p> 	<p data-bbox="580 365 1394 779">Description – The crowfoot grass is native to Africa and widely distributed throughout the tropics, subtropics, and warm temperate regions. A tufted annual or short-lived perennial species that can grow to a height of up to 75 cm. It has slender, erect and ascending stems, slightly stoloniferous with multiple branches. The stolons may creep and they root from the lower nodes yielding horizontally laid roots. Its name common name ‘crowfoot’ is derived from the digitate or sub-digitate inflorescence arranged in 2 to 6 unilateral, horizontal spikes. Crowfoot grass is a multipurpose and mainly utilized as fodder and liked by all classes of livestock. It is also used to stabilize sandy soils and control soil erosion. Though not considered a noxious weed or invasive species, Crowfoot grass can be troublesome in croplands under groundnuts, cotton, maize or rice cultivation.</p> <p data-bbox="580 813 1394 969">Ecological range – Crowfoot grass occurs in disturbed areas e.g. roadsides, abandoned cropland and degraded lands, especially on sandy soils. It can be found at an altitude range of between 0 and 2100 m. It does well in many ecological zones receiving an annual rainfall of 400-1500 mm.</p> <p data-bbox="580 1003 1394 1104">Soils – <i>Dactyloctenium aegypticum</i> tolerates a wide range of soils including those with high soil pH (alkaline) and salt concentration (saline). It responds well to nitrogen (N) fertilization.</p> <p data-bbox="580 1137 1394 1518">Forage value and seed production – In semi-arid pastoral lands, it makes valuable annual pastures. In its native range (East and South Africa), it has been used to improve the productivity of pastures. Crowfoot grass is also an excellent species for hay and silage making. This is because, once established, it grows fast. Moreover, it is drought-resistant grasses as it can quickly grow and produce seed during the rainy season, quickly replenishing the seed bank. <i>Dactyloctenium aegypticum</i> can be established from seed sown at a shallow depth (1 cm deep), prior to the onset of the rainy season in semi-arid lands. It is suitable forage species for free-range grazing and performs relatively well in overgrazed rangelands. Biomass yields range is from 3 to 6 tonnes DM ha⁻¹.</p>

