

# Tropical Forages

## *Cenchrus purpureus* & hybrids

### Scientific name



*Cenchrus purpureus* (Schumach.) Morrone

*Cenchrus purpureus* (Schumach.) Morrone × *Cenchrus americanus* (L.) Morrone

### Synonyms

***Cenchrus purpureus* (Schumach.)**

**Morrone:** Basionym: *Pennisetum purpureum* Schumach.; *Pennisetum benthamii* Steud.

### Family/tribe

Family: *Poaceae* (alt. *Gramineae*) subfamily:

*Panicoideae* tribe: *Paniceae* subtribe: *Cenchrinae*.

### Morphological description

Robust perennial forming large, bamboo-like clumps, spreading by short rhizomes; extensive root system penetrating to 4.5 m. Culms initially erect/geniculately ascending, 2–4 m tall, 1–2 (–3) cm diameter near the base and branched towards the top; outer culms becoming decumbent extending to 7.5 m and developing stolon-like characteristics, forming plantlets and rooting from lower nodes. Leaf blades green, sometimes purple, linear, 30–120 cm long, 1–5 cm wide, apex attenuate; abaxial surface glabrous, adaxial surface hispid or papillose-pilose at base, midrib prominent, margins cartilaginous, scaberulous; ligule a fringe of hairs 2–5 mm long; leaf-sheaths glabrous or with stiff hairs. Inflorescence a bristly spiciform panicle 7–30 cm long, 1.5–3 cm wide (excluding bristles), dense, usually yellow-brown in colour, more rarely greenish or purplish; axis terete, pubescent, bearing deciduous clusters of 1–5 spikelets subtended by an involucre, deciduous with the fertile spikelets; involucral bristles 8–16 mm long, numerous, one conspicuously longer bristle, 10–40 mm long; spikelets 5–7 mm long, terminal spikelet fertile, subsessile, laterals when present staminate with 1–2 mm pedicels. Caryopsis ellipsoid, or ovoid, dorsally compressed, concealed by floret, 1.8–2.2 mm long. About 3 million 'seeds' (fertile spikelets)/kg.

### Common names

*Africa, Southern:* olifantsgras (Afrikaans); madeanga, marianga (Angola); senjele (Nyanja); mfufu, mufufu (Shona)

*Africa, Eastern:* urubingo (Kinyarwanda); mabingobingo (Kiswahili); nsenjere, senjere (Malawi); ebibingo (Runyankole/Rukiga, Uganda); egada (Gisu, Uganda)

*Africa, Western:* djissouvè, essounsoun kpikpa, fan vovo, hènouvè (Benin); bekoko, besong, makoko, sosom e nyak (Cameroon); iangala a moome, maangala ma meome (Congo); chelié, dia, dian voli, né (Côte d'Ivoire); adai, akoko ani, anan hwerew, elanke akanla, gla,



Dwarf type at flowering



Robust perennial forming large, bamboo-like clumps. (King grass (L), Napier grass (R))



Inflorescence a bristly spiciform panicle



Seed units



*Pennisetum purpureum* Schumach. - 1, habit of flowering plant; 2, spikelet surrounded by bristles.  
Line illustration



Purple-leaved form, CATAS-Danzhou, China



Young growth (too early to cut)



Elephant grass (tall type) -too mature for forage



Leafy stage ready for harvest.



Minimum cutting height 15cm; early tiller regrowth

hwedie (Ghana); achalà, acharà, awo, car, daawar kadaa, epiri, eromo, fe, gawri ngabbu, iiline, ikpu, izai, izon usi, kyambama, mbiit, mboko ekpò, oghodogbo, ono, osi, toloore, ukpò ukwu, usi, uwa nor, uwua nor, yambamaa, yiwo (Nigeria); a anwo, anlal, bush shuga ken, chengjo, fa, fawa, ka staf, kulon na, kulu na, mbowi hei, molike, moloko, na, ngala, ngara, ngongoi, tamben (Sierra Leone); kyambama, daawaar kadaa, yambama (Hausa); moloko (Fula); tienghiéo (Kissi); hoyen (Guerzé); bô, gbô (Malinké); adà (Togo); eesun, eesun funfun, eesun pupa, iken, esisun, essu (Yoruba)

*Asia:* الشوم الأرجواني osheb el-feel (Arabic); □□ xiang cao (China); aane hullu, dappa naeppear hullu (India); rumput gajah (Indonesian, Malaysian); pokao (Japanese); слоновая травá (Russian); buntot-pusa, darai, darawi, gulalay, handalau, handalawí, lagoli (Philippines); ya nepia (Thailand); filotu, erguvani zencidarisi, hint darisi (Turkish); hati ghash(Urdu); cò duo (Vietnam)

*English:* bana grass, barner grass; bush sugarcane, cow cane (= bana grass), cow's sugarcane, devil's cane, hippomatus's corn, elephant grass, merker grass, napier grass, Uganda grass

*Europe:* Elefantengras (German); canne fourragère, fausse canne à sucre, herbe éléphant, napier (French); erba lefantina, erba ugandese, penniseto rosso (Italian)

*Latin America:* capim-elefante, capim-napiê (Portuguese); gigante, hierba elefante, pasto de Uganda, pasto elefante, yerba elefante (Spanish); gigante (Costa Rica); paja elefante (Ecuador); merkerón, zacate elefante, zacate gigante (Mexico)

*Pacific Islands:* erepani (Cook Islands (Atiu)); acfucsracsracsr (Kosrae); motie alefane (Niue); bokso (Palau); puk-soh (Pohnpei); vao povi (Samoa)

**Note:** This is such a widely cultivated grass that ethnic groups from many climatic regions have vernacular names for it. Names presented above by country and tribal groups is a large cross-section of such names but is not exhaustive.

## Distribution

### Native:

*Africa:* Angola; Cameroon; Côte d'Ivoire; Ethiopia (S); Ghana; Guinea; Kenya; Liberia; Malawi; Mozambique; Nigeria; Sierra Leone; Tanzania; Togo; Uganda; Zambia; Zimbabwe

### Naturalized/cultivated:

*Africa:* various

*Asia:* Bhutan; Cambodia; Cyprus; India; Indonesia; Israel; Laos; Malaysia; Myanmar; Philippines; Thailand; Vietnam

*Australasia & Pacific:* Australia (New South Wales, Northern Territory, Queensland, Western Australia); Cook Islands; Fiji; French Polynesia; Galapagos Islands; Guam; Hawaii, Micronesia; New Caledonia; New Zealand; Niue; Northern Mariana Islands; Palau; Papua New Guinea; Solomon Islands; Wallis and Futuna Islands

*Indian Ocean:* Réunion

*Macaronesia:* Madeira Islands; Canary Islands

*Northern America:* Mexico (Campeche, Chiapas, Nuevo León, Oaxaca, Tabasco, Veracruz, Yucatan); USA (Florida, Texas)

*Caribbean:* Antigua and Barbuda; Cuba, Grenada; Jamaica; Puerto Rico; St. Lucia



Cut too low; tiller death



Elephant grass as cut and carry Vietnam



Harvesting leafy dwarf Napier grass, Nepal (cv. Mott)



Feeding to goats, Nepal (cv. Mott)



Graze when leafy; animals do not eat stem

*Central America:* Belize; Costa Rica; El Salvador; Guatemala; Honduras; Nicaragua; Panama

*South America:* Argentina; Bolivia; Brazil; Colombia; Ecuador; French Guiana; Guyana; Paraguay; Peru; Suriname; Uruguay; Venezuela

## Uses/applications

### Forage

Mostly planted for cut-and-carry application, and but not well-suited to long-term grazed pastures. Young growth makes good hay, which can be fed as hay or pellets. Coarse stems in older growth make it unsuitable for hay. Makes good silage if harvested early, although inferior to maize and sorghum.

### Environment

Used for hedgerows and living fences, although extensive root system competes with adjacent crop. Old growth becomes too coarse to be of value for anything other than soil conservation.

### Other

*C. purpureus* has played an important role in the development of the 'push-pull' (or stimulo-deterrent diversion) pest control strategy, although *Urochloa* hybrid cv. Mulato II is being increasingly adopted for this purpose. It is also suitable for paper making (similar to bamboo). The high dry matter yielding ability has drawn attention to its potential as biofuel, and its high uptake of Mn and As suggest a role in phytoremediation of heavy metal contaminated soil. Bana grass is commonly used as a windbreak in horticultural crops and orchards.

## Ecology

### Soil requirements

While *C. purpureus* can be grown on a wide range of soil types, it grows best in deep, well-drained friable loams with a pH of 4.5–8.2 (mean 6.2) provided fertility is adequate. There appear to be genotypic differences in salinity tolerance, with some researchers reporting low tolerance and others moderate to high tolerance. Its adaptation to extremely acid soils suggests a tolerance of high levels of Al and Mn, although differences in tolerance to aluminium has been shown to vary among cultivars.

### Moisture

In the wild, it is normally found only in areas with rainfall >1,000 mm, and on river banks in areas of lower rainfall. Although extremely drought tolerant by virtue of deep root system, it needs good moisture for production. *C. purpureus* does not tolerate prolonged flooding or waterlogging and does not survive in areas where the seasonally fluctuating water table approaches the surface in the wet season.

### Temperature

It produces best growth between 25 and 40 °C, and little growth below about 15 °C, with growth ceasing at 10 °C. Tops are killed by frost, but plants re-grow with the onset of warm, moist conditions. Grows from sea level to over 2,000 m elevation.

### Light

Moderate shade tolerance, about equivalent to that of *Setaria sphacelata* and *Urochloa decumbens*.

### Reproductive development

An obligate quantitative short-day plant, with a critical photoperiod of 12–13 hours, flowering under a relatively wide range of photoperiods, e.g. flowers January to June in South Africa. It sets seed apomictically and through cross-pollination, male and female flower parts emerging asynchronously. There is variation among ecotypes in flowering time. Seed set is usually poor, possibly due to low pollen viability.

### Defoliation

Normally cut at 15–30 cm above ground, although difficult to maintain constant cutting height. Cattle select mostly leaf, largely avoiding the stem fraction, even when it is chopped. Since the proportion of stem increases with age and height, the stand should not be allowed to grow >1.5 m before cutting, to ensure cut material is mostly leaf. Regular cutting at ground level to 10 cm leads to declining yields and ultimate plant death.

### Fire

Recovers well following fire, and can dominate fire-adapted savannah communities. Seldom dry enough to burn under normal circumstances.

## Agronomy

Guidelines for establishment and management of sown forages.

### Establishment

Can be established from seed (no post-harvest dormancy), although plants produced are not necessarily like the parents due to

outcrossing. However, Napier grass is almost invariably planted from setts/cuttings (pieces of cane) or splits (rooted pieces of clump). Setts are taken from the basal 2/3 of moderately mature stems and should contain at least 3 nodes. These are pushed into the soil at 45°, basal end down, with 2 nodes buried. They can also be planted horizontally into a furrow, to a depth of 5–10 cm. Normally planted in rows 0.5–2 m apart, and 0.3–1 m apart within rows, depending on rainfall and cutting management. Close spacing is required for soil conservation contour hedgerows and for high rainfall environments. More open spacing is used in drier environments.

## Fertilizer

Should be planted into fertile soil. Once established, Napier requires, 150–300 kg/ha/yr N, together with other nutrients as indicated by soil tests. Responses at much higher levels of applied N have been obtained. Such nutrient inputs are particularly necessary in cut-and-carry systems where large amounts of plant nutrient are removed in the forage. Yields decline rapidly if fertility is not maintained.

## Compatibility (with other species)

Competes vigorously with other species with adequate fertility and moisture. Weeds invade if fertilizer regime relaxed.

## Companion species

Grasses: Not sown with other grasses.

Legumes: Normally not sown with legumes, but will grow with vigorous twining legumes such as *Neustanthus phaseoloides*, *Neonotonia wightii* and *Centrosema molle*, or with the shrub/tree legume, *Leucaena leucocephala*.

## Pests and diseases

Napier grass stunt (NGS) disease associated with the 16SrXI phytoplasma (*Candidatus Phytoplasma oryzae*) is by far the most devastating disease of Napier grass. Napier is also attacked by another phytoplasma associated with African sugarcane yellow leaf (ASYL) disease. Both cause foliar yellowing, small leaves, proliferation of tillers, and shortening of internodes with severely stunted clumps. Often, the whole grass stool is affected with a complete loss in yield, leading to eventual death of the infected plant.

About 70 different fungi are reported to infect *C. purpureus*. The three most serious are eyespot caused by *Helminthosporium* spp, snow mould or white mould caused by *Beniowskia sphaeroidea* and head smut caused by *Ustilago kamerunensis*. The last one is the most damaging causing major productivity losses, but is currently restricted to the African continent. *Pyricularia grisea* and *P. oryzae* also produce leaf spots on infected plants, although some varieties are resistant. Also attacked by *Pectobacterium carotovorum*. Pseudo-Fiji Disease, chlorotic streak, a disease of sugarcane, leaf mottle virus and nematode attack by *Aphelenchus avenae*, *Meloidogyne incognita acrita*, *M. javanica* and *Pratylenchus brachyurus* can also lead to reduced performance.

## Ability to spread

Spreads by seed, usually into disturbed areas, but mostly by short rhizomes and tall stems that fall and root at the nodes. Stem pieces are easily broken off and can contribute to spread.

## Weed potential

Listed as an invasive species in the Pacific Islands and USA (Florida). Can be controlled by regular mowing or herbicide. Pathogenic fungi, *Drechslera* and *Exserohilum* are being tested to control weedy stands of *C. purpureus*.

## Feeding value

### Nutritive value

Varies greatly with age of regrowth (leaf:stem ratio) and fertility, particularly nitrogen, e.g. 6 week regrowth 10% CP, 10 week regrowth 7.6% CP. Can give up to 2-fold difference in CP level. CP and IVDMD levels of leaf range from 9.5 to 19.7%, and 68–74% respectively. Digestibility of total samples declines rapidly with age of regrowth due to the high levels of lignin in the stem.

### Palatability/acceptability

Extremely palatable to all classes of stock provided young and leafy. Livestock avoid stem in grazed areas. Even when harvested Napier grass is chopped for ease of feeding out, stock try to select leaf from the leaf-stem mixture.

### Toxicity

Can cause nitrate poisoning in cattle if sole component of diet. While oxalate levels of 2.5–3.1% of DM have been recorded, there were no problems in livestock performance.

### Feedipedia link

<https://www.feedipedia.org/node/395>

## Production potential

### Dry matter

Yields depend on cultivar, soil fertility, moisture, temperature and management. DM yields of 10–30 t/ha/yr are common if the stand is well fertilized, and 2–10 t/ha/yr if unfertilized. More frequent cuts (up to 45 days) give less dry matter, but better leaf production than infrequent cuts. It is important to recognize that many of the extreme yields (up to 85 t/ha/yr DM) claimed by advocates for a particular

cultivar have probably been obtained under ideal soil, environment and management conditions and may not be reproducible in a practical situation. Further, high total yields are often associated with high stem yields, which in turn reflects high yields of indigestible fibre and poor animal production.

## Animal production

As with dry matter, animal production from *C. purpureus* depends on growing conditions (including management) for the grass. Liveweight gains of 1 kg/hd/day during the growing season and 480 kg/ha/yr, and milk yields of >11 kg/day (4% fat) are achievable. Capable of carrying 2–7 beasts/ha in a grazed system.

## Genetics/breeding

*C. purpureus*: cross pollinating, also apomictic,  $2n = 27$ ,  $4x = 28$ ,  $8x = 56$ ; tetraploid genomes A'A'BB

*C. purpureus* × *C. americanus* hybrids:  $2n = 20, 21$ .  $2n = 3x = 21$ , genomes AÁB (*C. americanus*  $2n = 2x = 14$ ; genome AA)

A considerable amount of breeding and selection has been done in a number of countries within *Cenchrus purpureus* and with interspecific hybridization with *C. americanus*. Selection for morphology, productivity and disease resistance has resulted in the release of a multitude of cultivars. Molecular genetic diversity studies of Napier grass genotypes from different parts of Africa have been undertaken with a view to adopting a more refined and directed approach to plant improvement.

**Note:** Cv. Maralfalfa is just one of many hybrids between *Cenchrus purpureus* and *C. americanus* used commercially. Claims in some publications that it was derived from a multiple cross involving *Cenchrus purpureus*, *Paspalum macrophyllum*, *Paspalum fasciculatum*, *Axonopus purpusi*, *Medicago sativa* and *Phalaris arundinacea* are demonstrably misleading and should be discounted.

## Seed production

Seed rarely harvested.

## Herbicide effects

Atrazine at 6 kg /ha can be used for establishment. Controlled with glyphosate.

## Strengths

- High dry matter yields
- Very palatable, high quality forage when properly managed
- Drought tolerant

## Limitations

- Needs high fertility
- Matures rapidly, becoming stemmy
- Must be planted vegetatively
- Frost susceptible

## Selected references

Bogdan, A.V. (1977) Tropical Pasture and Fodder Plants. Longman Inc., New York, USA. p. 233–243.

Mannetje, L.'t (1992) *Pennisetum purpureum* Schumach. In: Mannetje, L.'t and Jones, R.M. (eds) Plant Resources of South-East Asia No. 4. Forages. Pudoc Scientific Publishers, Wageningen, the Netherlands. p. 191–192. [edepot.wur.nl/327785](http://edepot.wur.nl/327785)

Negawo, A.T., Teshome, A., Kumar, A., Hanson, J. and Jones, C.S. (2017) Opportunities for Napier grass (*Pennisetum purpureum*) improvement using molecular genetics. *Agronomy* 7(2):28. [doi.org/10.3390/agronomy7020028](https://doi.org/10.3390/agronomy7020028)

Nyambati, E.M., Muyekho, F.N., Onginjo, E., and Lusweti, C.M. (2010) Production, characterization and nutritional quality of Napier grass [*Pennisetum purpureum* (Schum.)] cultivars in Western Kenya. *African Journal of Plant Science* 4:496–502. [academicjournals.org/journal/AJPS/article-abstract/77FA34E12164](http://academicjournals.org/journal/AJPS/article-abstract/77FA34E12164)

Reis, G.B. dos, Mesquita, A.T., Torres, G.A., Andrade-Vieira, L.F., Pereira, A.V. and Davide, L.C. (2014) Genomic homeology between *Pennisetum purpureum* and *Pennisetum glaucum* (Poaceae). *Comparative Cytogenetics* 8(3):31–41. [doi.org/10.3897/compcytogen.v8i3.7732](https://doi.org/10.3897/compcytogen.v8i3.7732)

## Cultivars

Over the years, numerous cultivars of *C. purpureus* and *C. purpureus* × *C. americanus* hybrids have been released, many of which are no longer extant. Each country has developed its own range of cultivars according to respective perceived needs. Cultivars with high yields and high leaf:stem ratio have been selected for forage; others with a complete focus on high energy values have been selected for

biofuel application; and a number of tall varieties have been identified to be used in windbreaks for orchards and horticultural crops. More recent breeding effort is being directed towards improving nutritive value and disease resistance. It is not feasible or relevant to list the huge range of national and purpose-specific cultivars with claimed strengths in this publication.

## Promising accessions

None reported.

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