Napier Grass

Pennisetum purpureum

Napier grass is one of the important perennial tropical forage crop belong to family Poaceae.

It is also called Uganda grass or elephant grass.

It is native to Africa but is now grown in many tropical countries.

It is a C4 plant and can grow well in marginal land.

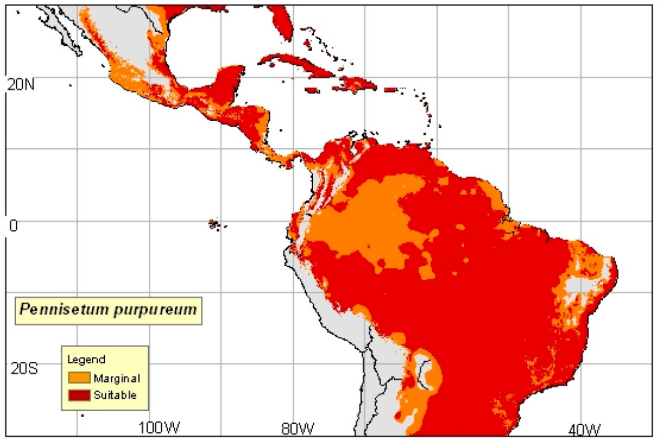
The grass grows tall and forms large clumps like bamboo.

A truly multi-purpose plant suited to climate change!

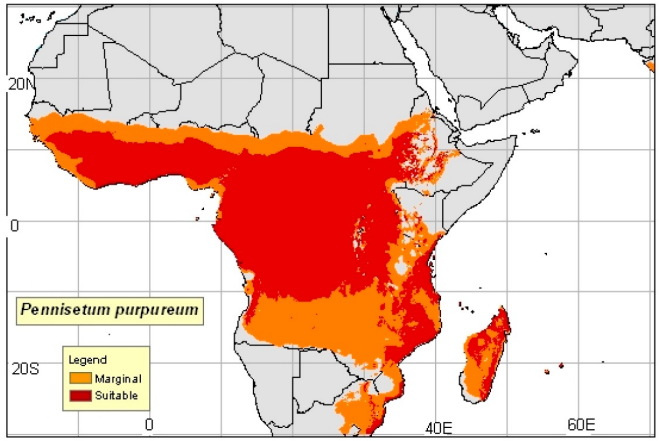
Napier Grass – Where it is grown

Napier grass is native to Sub-Saharan Africa from where it is believed to have been distributed to other tropical and subtropical regions around the world. It has been reported to be adapted to grow across a wide range of soil conditions and agro-ecologies, from sea level to 2100 m, and it can withstand minor dry spells, although it grows best in areas where the annual rainfall is between 750 and 2500 mm.

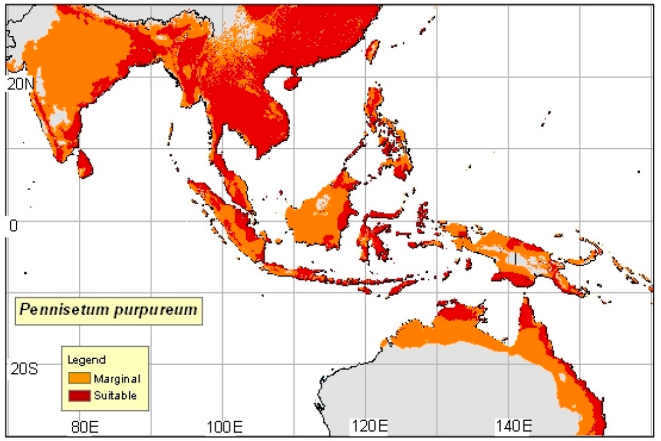
Given its wide agro-ecological adaptation, Napier grass has been naturalized in areas of Central and South America, tropical parts of Asia, Australia, the Middle East and the Pacific islands. As a result, today it is widely grown in tropical and subtropical regions of the world, for use predominantly as animal fodder



Caribbean, Central and Southern America regions



Africa



Melanesia, Southeast Asia and surrounding regions

C4 Photosynthesis and Climate Change Adaption

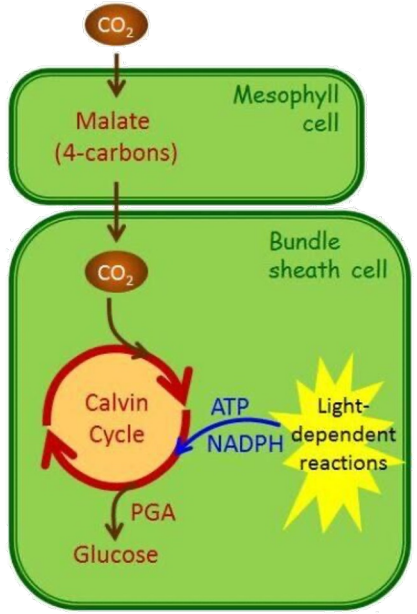
Plants “eat” carbon dioxide (CO2) from the atmosphere and use the Sun’s energy to convert it into sugars in a process is called photosynthesis. This process is probably the most valuable biochemical process on Earth. Without it we would have no food.

Corn, sorghum & sugarcane belong to a special plant group known as C4, because they fix CO^2 into a four-carbon atom carbohydrate. C3 plants (most plants including soybeans, rice, canola, and all trees) fix CO^2 into a carbohydrate with only three carbon atoms. On average, C4 crops are 60% more productive than C3 crops.

Plants with the C4 photosynthetic pathway account for some 30% of global terrestrial carbon fixation and dominate today's tropical savannahs and grasslands.

C4 plants also have a special type of leaf anatomy (Kranz anatomy), they tolerate high temperatures, they show a response to high light intensities, they lack a process called photorespiration but have a physiological CO^2-concentrating pump, which leads to high photosynthetic efficiency in warm climates and low atmospheric CO^2 concentrations.

C4 plants with no photorespiration, use water well, and have more efficiency in capturing carbon from CO^2. The C4 metabolic pathway uses about half the water used by C3 plants.



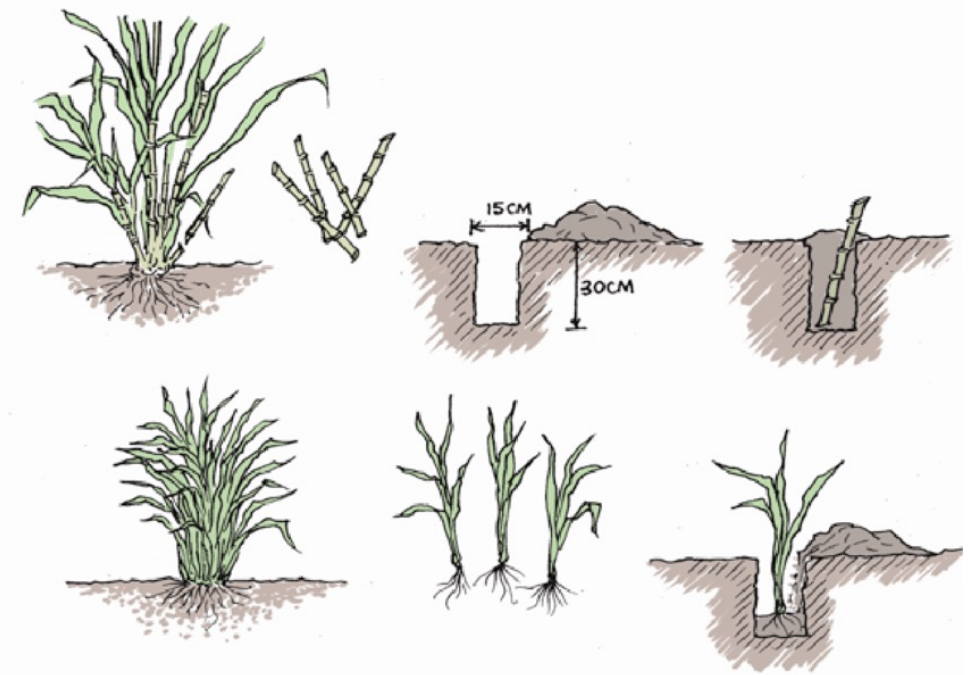
Napier Grass – Versatile Crop for Small Rural Farmers

- It has high crisp leaves.
- Is a high yielding green fodder.
- It has a high leaf stem rate
- Its leaf length are 6 - 8 cm broad.
- Roots around the nodes can quickly grow
- It grows up to a high height 12 feet to 15 feet
- It can be harvested eight times a year
- It can yield 180 to 200 tons per acre per year
- High in lignocellulosic fibers for fuel when older
- The yield is made in a short period of time.
- It is gender friendly. Grown by men and/or women.

https://www.rehobothorganicfarms.com/supernapier

Planting Napier Grass is Simple

Napier grass planting needs no seed and can be established from root splits or canes. It can also be planted alone or intercropped with forage legumes. Two methods of planting Napier grass are the conventional method and the tumbukiza method.



Conventional method

The conventional method involves planting one cane (with 3–4 nodes) or root split in holes 15–30 cm deep. The spacing is 0.5 m x 0.5 m in areas with over 1400 mm of rainfall. In areas with 950–1400 mm rainfall the spacing is 1 m x 0.5 m. When cane cuttings are used, bury the nodes, leaving one node above the soil surface.

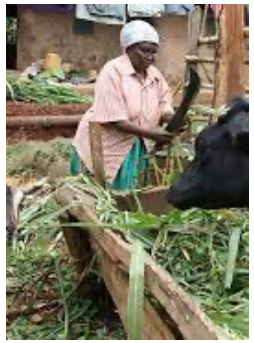
Tumbukiza method

'Tumbukiza', a Kiswahili word meaning 'placing in a hole', is a new planting method started by farmers to increase productivity per unit of land. The method, which involves planting cuttings or root splits in well-manured holes, produces more herbage yields than the conventional method.

Napier Grass – A Circular Economy for Rural Farmers

Cut & Carry
Feed
12-16 weeks

Stalk Harvest
& Pelletise
16-24 weeks



Animal Fodder Feed Cycle

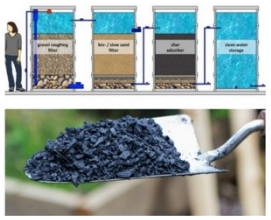
Biomass Cooking Fuel Cycle

Manure
Recycled

BioChar
Recycled

Other Napier Grass Uses

Building
Material



BioChar
Filtration

Napier Grass is easily cultivated and can replace the income generated by cutting trees for making charcoal

Napier Grass as Livestock Silage or Hay

Napier grass is a favourite of many small holder dairy farmers.

The grass grows relatively fast and can give “elephant” feeds after just three months.

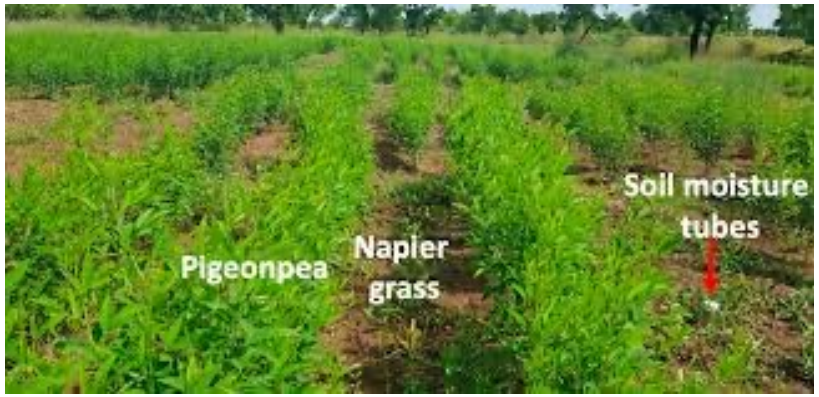
It can withstand drought conditions, this coupled with dwindling land size for small dairy holders has made it a preferred choice.

It has good root systems that can cover a wide area, and this has made it a master of soil erosion control, especially on riverbanks. Its invasive nature also endears it as a good weed control as it can easily outgrow and smother other plants around. Napier is also easy to propagate.

It has good dry matter content in addition to other nutrients like proteins. Its nutritive value can will vary depending on several factors key among them how it is cared for in the field, how it is prepared on farm or how it is conserved.

It is mainly used to feed livestock (including goats and pigs) in cut and carry feeding systems and is a multipurpose forage crop that can be grazed directly or made into silage or hay.

NG Intercropping with legumes boosts food and livestock productivity



Seasonal and low forage availability and quality, shrinking of grassland area, and poor grassland management are the main causes of low soil fertility and animal production in tropical grasslands.

A napier grass-forage legume mixture can improve the nutritional plane of stock as forage legumes generally have a higher nutritive value than tropical grasses and can fix atmospheric nitrogen through their symbiotic association with rhizobia. Intercropping also improved soil health and fertility, forage yield, and stability and reduced weed invasion.

The mixture also has the potential to produce higher total dry matter yields, suppress weeds and improve soil fertility. Therefore, the integration of forage legumes into a napier grass fodder system may provide an effective means of increasing forage and dairy productivity for smallholders in highland areas in Africa.

Napier Grass Harvested as a Heating Fuel

If Napier grass is not harvested early i.e. used as animal feed, the seeds fall out and the grass lignifies. As a result, the crop can no longer be used as cattle feed.

Making biomass pellets is therefore not in competition with the use of the grass as animal feed.

The Napier grass is harvested by locals by hand and transported in donkey carts to the processing area where it is chopped and dried ready for pelleting.

Napier Grass – Pellet Production Process

Harvesting:	The harvested elephant grass is 30 mm in diameter and 4 meters in length with about 70% water content.
Chopping:	It will be cut into small pieces by using hay cutter to a size should be <5cm.
Drying:	In drying process, the moisture content is reduced to around 15%. This is done by spreading it out to dry on a hard clean surface.
Milling:	The chopped and dried material has to be milled to a particle size of < 5mm
Pelleting:	After drying and milling, it is transferred to the biomass pellet production line to be pelleted into 6mm pellets
Cooling:	Cooling the pellets hardens the lignin and makes the pellet stronger
Bagging:	Bagging in plastic bags is the last part if the process

Napier Grass Pellets: Chemical Analysis

Proximate Analyses (wt. %)	
Moisture Content (Dry Basis)	4.5
Volatile Matter (Dry Basis)	85.52
Fixed Carbon (Dry Basis)	8.17
Ash (Dry Basis)	6.33
HHV (MJ/kg)	16.33
Ultimate Analyses (wt. %)	
Carbon	45.10
Hydrogen	5.94
Nitrogen	0.45
Sulfur	0.00
Oxygen (By Difference)	48.52

Napier Grass Pellets have relatively low amounts of fixed carbon and ash contents of 8.17% and 6.33%, respectively, which are both considered as suitable characteristics for gasification.

The HHV at 16.33 MJ/kg is an adequate energy content of biomass and ensures a highLHV of the producer gas. High ash content negatively affects the HHV .

Napier Grass as Sustainable Cooking Fuel Resource

40 Households Example

Charcoal from Harvested Wood (24 Tons / Hectare after 10 years)

Single Household: 400 kg Charcoal / Year @ 20% Thermal Efficiency
= 2,400 kg Wood = 0,1 hectare of forest

40 Households: **4 Hectares of Natural Forest**
Sustainability: 40 Hectares of total forest

Pellets from Harvested Napier Grass (20 Tons / Hectare per year)

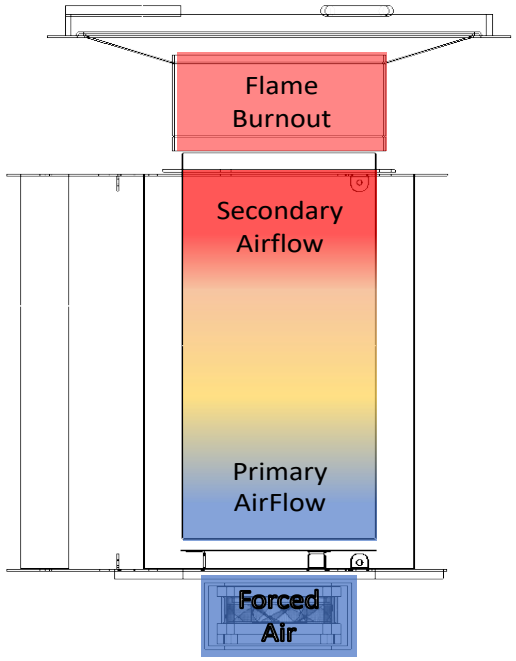
Single Household: 400 kg Pellets / Year @ 40% Thermal Efficiency
= 500 kg Dried Napier Grass = 0,025 hectare of land

40 Households: **1 Hectare of Cultivated Land**
Sustainability: 1 Hectare of irrigated cultivated land

Biomass Pellets and Micro-Gasification Cooking

In numerous independent cooking tests, forced air gasification updraft combustion has proven to meet WHO tier 4 standards for efficiency, low emissions and safety. It is considered an advanced cooking solution by the ESMAP Multi-Tier Framework (MTF) for Cooking

- *Optimised for High Density Fuels*
  - *Wood Pellets*
  - *Grass Pellets (C4 Plants)*
  - *Coconut Shells*
- *Fan Assisted Air Flow*
- *40% Combustion Efficiency*
  - *3x Open Fire*
  - *1,5X ND Gasifier*
- *Low CO emissions*
  - *Low PM2.5*
  - *Low CO*



COOK TOP
Pot Stands &
Flame Tube

GASIFIER
TLUD Biomass
Fire Chamber
With Primary
And Secondary
Combustion

FAN BOX
Fan with Speed
Controller & Battery

Sample Test: FabStove Combustion with NG Pellets

Raw Samples: Chopped Napier Grass harvested from Harmony Gold Mine, Welkom, Free State

Pellets: 6mm Pellets made in Jones Flat Die Pelletiser

Gasification: FabStove FA-TLUD (100mm Diameter)

Temperature: >700C

Burn Time: Normal ve other fuels

Observations: Fine White Residue in fire chamber.

Tested in FabStove FA-TLUD