# *Brochure on forage production (Establishment management, harvest)*

## Executive summery

Feeding of livestock is a critical point in all livestock production. Proper feeding is influencing livestock's development, health, productivity and reproduction rate. This applies for all sectors of livestock keeping. Of course, also other factors like genetics, health care, animal welfare etc also influence the performance of cows, but even if all these elements are well respected, feeding will be the determining element for reaching out to the dairy cows' potential. It is a well known fact, that many dairy cows are underfed in quantity and quality. This leads to under performing cows and makes dairy farming less economic.

It is also well known that feeding costs have a share of up to 70% in dairy production and such an interesting trigger. If the dairy farmer manages to feed its cows with better quality feed at a lower cost, dairy farming will become much more economic.

Production and feeding of forages is a way for better feeding and higher profitable dairy farming.

This brochure on forage production is providing you with information on forage production. Most information is extracted from other earlier published materials and combined in this brochure to give you an overview from establishment, management, harvesting to feeding. It also shows you on some examples how profitable forage growing can be and gives some ideas of earning money with forages.

You also find links to Shamba shape up episodes on improved forages as well as for a series of videos explaining forage production and use.

## Which improved forages do we recommend

Forages are defined as planted feed. This can be different kinds of plants like grasses (e.g. Brachiaria, Panicum), legumes (e.g. Desmodium, Vetch, Crotolaria), bushes or trees. They all deliver high quality forage and have the potential to improve the cows' diet significantly.

We present here:

**Brachiaria Hybrids Mulato 2, Cayman and Cobra**: Hybrids are a result of a long term breading process to achieve better performing plants compared to the plants you can find in the natural environment. These Hybrids are registered and commercially available in Kenya. **Camello** is a new bread which has good resistence to draught and lower susceptibility to spidermite attacks. This Hybrid is not yet registered and commercially available in Kenya.

**Brachiaria Cultivars Basilisk, Xaraes, Piata, MG4**: cultivars are a result of a long term selection process to identify the best performing ones out of plants you can find in a natural environment. The Cultivars are registered in Kenya (by KALRO) but the commercial availability is not yet assured.

**Panicum Maximum Mombasa/Siambasa, Masai**: While Panicum Mombasa is registered and commercial available in Kenya, Masai is not yet registered nor commercial available.

**Crotolaria juncea Sunnhemp**: is a dual purpose legume for soil improvement/green manure and can be used as forage.

There are many more forage plants which are tested and some which are already on the market, we concentrate however in this brochure on the ones mentioned before.

### Establishment

Brachiaria and Panicum Grass can be established using three methods, these are:

- Direct sowing of seeds in the field (Brachiaria, Panicum and Crotolaria)
- Sowing seeds in a nursery and transplanting seedlings in the field (Brachiaria and Panicum)
- Planting using vegetative splits from well established Brachiaria or Panicum grass.

### Land preparation

Prepare enough land for your animal needs or the available planting material before rains begin. Seedbed preparation should be done well before the onset of rains. If the piece of land is prone to obnoxious weeds, e.g. couch grass, herbicide spraying is advisable to systematically control these weeds which would otherwise be difficult to control after germination. Plough to about 25 cm depth and harrow the land to obtain a fine tilth, necessary for seeds that are small. Ideally the harrowed land will be slightly compacted with a roller to avoid movement of seeds into deeper levels. Preferably, avoid sloping and uneven land for lay the plots and minimize likely variations in performance.

To support the establishment of the Brachiaria and Panicum grass plants apply 200 kg/ha (80 kg/acre) of a phosphorus dominated fertilizer (DAP) to support root development.

### Direct sowing of seeds in the field

The forage seeds should be planted in a well-prepared seedbed as the seeds of Brachiaria and Panicum are very small.

Depending on the size of the plot to be planted, the seeds can either be planted by a seed driller (must be adapted to the small seed size) or manually. The planting can be either by drilling or broadcasting. If seeds are broadcasted the seed need is higher as in row planting. In case of broadcasting raking by the help of branches is creating a light coverage by soil of the seeds.

We recommend to plant the seeds in rows at a spacing of 30 cm in the rows and a distance of 45 cm between the rows for Brachiaria and Panicum. This eases the weeding while the establishment phase as such the young forage plants are easier to distinguish from herbs and other grasses.

For manual planting use 4-5 seeds per hole, i.e. pinch with two fingers.

The seeds should not be buried below 1(-2 cm) of depth. Cover the seeds with fine soil and assure a good seed – soil contact by compacting the filled in soil (e.g. by hand, foot or a roller).

Planting to take place at the onset of rains. Rainfall of about 30 mm or about two days of moderate raining would suffice to have planting done.

## Seed rates will differ by species as stipulated below

| Species | Seed rate Kg / ha | Seed rate Kg / acre | Seed rate Kg / 1000 sqm | (starter) fertilizer kg/ha DAP | DAP Kg / acre | DAP Kg/ 1000 sqm |
|---|---|---|---|---|---|---|
| Brachiaria | 8 | 3.2 | 0.8 | 200 | 80 | 20 |
| Panicum | 4 | 1.6 | 0.4 | 200 | 80 | 20 |
| Crotalaria | 40-50 | 16 - 20 | 4-5 | | | |

## Depth and spacing

| Species | Seeding depth (cm) | Spacing between the lines (cm | Spacing within the lines (cm) |
|---|---|---|---|
| Brachiaria | 1 (-2) | 45 | 30 |
| Panicum | 1 | 45 | 30 |
| Crotalaria* | 1-2 | 30 | 12 |

* Crotalaria is an annual plant and has to be reseeded for every production circle

**Sowing seeds in a nursery and transplanting seedlings in a field**

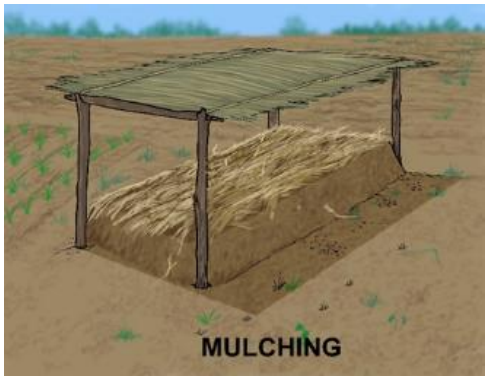
Passing by a nursery and transplanting the seedlings to the field demands for extra effort, but offers some advantages. As the nursery is of a limited size, it is much easier to create and control the best conditions for the germination of the seeds and the development of the seedlings, which reduces the necessary amount of seeds. It also allows to harvest and transplant seedlings at a favorable time when the field has the best conditions to guarantee the successful establishment of the grasses.

(Illustrations / drawings: Ben Lukuyu and Simon Ndonye – ILRI)

Measure the nursery area, ensuring it's 1x5 m and double dig nursery to a fine seedbed. Raise seedbed high by 0.5 m


Make the furrows <2 cm deep along the row at a spacing of 15 cm


Drill 0.5 kg of seeds, eenly in the furrows and cover lightly with soil. Ensure seeds are covered by the soil and mulch with grass




Cover the seedbed with shed

**Artisanal silage making through 'service provider enterprises' in Kenya**

Remove the grass mulch after 5-7 days when germination starts to allow seedlings to grow.

Manually remove emerging weeds during early stages of establishment.

Gradually remove shade covering the seedlings from week 3 to allow in more light.

Seedlings will be ready for transplanting within 4-6 weeks.

Dig holes at a distance of 30cm in the line and 45 cm between the lines in the field and transplant during wet season in cool hours of the day

**Planting using vegetative splits from well-established Brachiaria / Panicum grass tussocks**

- Brachiaria and Panicum grass can also be established from splits.
- Prepare land as if you are transplanting seedlings in the field (described above)
- Transplanting splits should be done after rains and when the soil is wet enough (2-3 days of raining)
- Remove the splits from healthy grass tussocks together with roots and attached soil.
- Take care not to damage the roots or remove attached soilas this reduces the chance of the survival of the splits. Prune back the upper parts of the grasses to about 15 cm length to reduce the evaporation.
- Use a spacing of 30x45 cm to plant the splits

Disadvantage: It is difficult and needs more people because splits are bulky especially if you are planting a large piece of land

## Management

- Inspect the field one week after transplanting and replace the seedlings that have died.
- In case of direct seeding inspect the field 1 month after establishment and fill the gaps with splits if available at that time. If no splits are available gapping should be done about 6 months after the seeding when the grass plants are fully established and strong enough to harvest splits. Too early splitting might weaken the plants and should be avoided.
- Forage fields with a lot of gaps do not reach to its full production capacity and should be avoided!
- Brachiaria and Panicum grass can overcome weeds well once it is well established. However, farmers will need to control weeds manually in the early stages of growth. The plots should be

kept weed free. If herbicides that control grass weeds are sprayed before land preparation, weeding after establishment will be made easier, as there are less grass weeds regrowing out of roots. Grass seeds are usually slow in establishment and it is important to minimize weed competition at early development stage, being it from weed grasses or broad leafed weeds. When well established and a harvest is done, manual weeding should be done if necessary, before top-dressing with nitrogenous fertilisers.

- To maximize regrowth, top-dress with organic manure or nitrogenous inorganic fertilizer (e.g. CAN, 60-80 kg / acre / year, respective 200 kg / ha / year). Forage production is a crop production. Intensive production of forage is mining minerals from the soil which has to be replaced to keep up the productivity of the forage plots.
- During the growing period inspect the crop for any pests and diseases. Red spider mites and shoot borers are common pests that attack Brachiaria grass. Work to keep plants healthy and the area around the crop free of weeds to keep red spider mites away. Also make sure plants have enough water. The water will help keep the spider mites away as they prefer very dry environments. If red spider mites attacks occur, harvest the Brachiaria and feed it to your animals, even if the grass has not reached yet the normal harvesting stage. The regrowth normally is less attacked.
- Brachiaria and Panium grass does not have to be planted every season. Once established and managed well, Brachiaria and Panicum for up to 10 years or more.
- Crotalaria juncea Sunnhemp is a dual purpose legume, which can be used as a soil improvement plant or as a forage. It reaches it's harvest stage 6-8 weeks after establishment and is very little demanding for soil humidity. Crotalaria has to be reseeded for every production circle.

### Harvesting

- The stage of harvesting will differ according to different climates. But generally, Brachiaria and Panicum grass will be ready for first harvest 12 weeks after establishment. Thereafter under cut and carry and with good rains (rainy season) a harvesting interval of about 4 weeks (25-35 days) is feasible depending on the climate. While the dry season, production of the grasses goes on in a reduced intensity and it takes about 10 weeks (70-75 days) to harvest.
- Practical advise to farmers is to harvest when flowering starts to set in. Quality of forage starts to drop after flowering begins.
- Cut the grass at a height of 5-10 cm above ground using a machete or a sickle. A motorized brush cutter or tractor based grass cutters can also be used. Cut at this height eases and accelerates regrowth.
- When harvested at the right stage, Brachiaria stems are soft and the cow can eat everything without chopping. When harvested late, Brachiaria grass becomes hard hence harvesting and chopping is harder.
- Panicum max. Masai can be treated like Brachiaria. Panicum max Mombasa will develop thicker stems, especially when harvested late, respectively at a height of over 1.5 m height. Best quality forage is harvested when reaching max 1.5 m. Chopping is recommended, even at that stage of development.
- Crotalaria should be harvested when first flowers set up, which is 6-8 weeks after establishment.

| Forage Variety | Time to first harvest (days) | Cut interval rainy season (days) | Cut interval dry season (days) |
|---|---|---|---|
| Brachiaria cv and hyb. | 90 -100 | 25-30 | 75 |
| Panicum | 75-100 | 25-35 | 60-70 |
| Crotolaria | 42-56 | | |

## Conservation

The above described forage can either be fed fresh to the livestock or being conserved for the periods of feed scarcity. As these periods of feed scarcity can last for several months, depending on the rainfall patterns, it is important to have enough conserved high-quality feed to bridge these periods. Underfed cows, in quality and quantity, react with a bad health status, higher sensibility to diseases and a lowered milk production.

There are mainly two methods of conserving the forages, haying and ensiling. Which conservation method will be adequate depends on the weather, preferences of the farmer, the skills and financial resources.

**Hay making** is the easier and cheaper way of conserving forage. The ready to harvest forage has to be cut and dried for 3-5 days depending on the intensity of the radiation. Choose a period of announced dry days to cut the grass, spreading it out in thin layers over the field and turning it upside down every day is accelerating the drying process. The faster the forage dries, the higher will be the quality of the produced hay. After 3-5 days the hay is ready to be bailed. The bailed hay has to be properly stored in a barn, under a shed or covered by appropriate materials to avoid the exposure to rain.

All the Brachiaria cultivars and hybrids qualify for hay making, as well as the Panicum max. Masai and Crotolaria juncea Sunnhemp.

**Silage making** is also possible with all the forages described and is a method which can also be applied under conditions of higher humidity or absence of sunshine. As the forages contain very little amounts of sugar, which is necessary to feed the bacteria which transform the fresh grass into silage, molasses has to be added. The silage making demands more inputs and skills as haying but is an excellent method to conserve forage over a long period.

All the Brachiaria cultivars, hybrids, Panicum max Masai and Mombasa qualify for silage making.

## Feeding Brachiaria and Panicum grass

- A mature cows weighing 400 kg requires per day an amount of the equivalent of 3% of its live weight expressed in dry matter.
- On fresh basis it means the cow can eat about 80 kg of fresh grass daily.
- If feeding hay, a mature cow would take about 12 kg of hay every day (about 1 bale of hay every day).
- If feeding silage, a mature cow would take about 30 kg silage every day.
- Milk consist of 80 % water, make sure that your cows always have access to enough clean water.

## Business cases, how forage can increase income and create jobs

Forage is offering several opportunities to improve the income situation of the rural population. We developed 4 business cases which are described here and are linked directly to the forage. Besides these opportunities there is a much bigger effect when the whole value chain is included in the consideration, e.g. seed provision, transport of the milk to the dairy enterprise or the lower seasonality of milk delivery to the processors.

This business case is entirely taken out of the Study report: Fodder value chain analysis in Western Kenya: Opportunities for business development (David Miano Mwangi, PhD and Eunice Onyango, 2019) commissioned by GfA for the Green Innovation Center.

This report was included to give a wider picture on the different business opportunities around forage production.

### Bracharia Seedling Nursery Business

Bracharia seeds can be directly sowed in well prepared seed bed however, a better stand can be established if the seeds are first planted in a nursery. Nursery establishment has several advantages over direct drilling of seed in the field:

1. Less seed is used: Grasses including Bracharia are small seeded and not easy to handle. Therefore, when they are directly drilled the amount of seed used is high. The recommended seed rate is 3 kg per acre. The seed is drilled in shallow rows 50 cm apart. After germination the stand is thinned to give a spacing of 25 cm between plants. This gives a stand with approximately 32,000 plants per acre. When the seed is planted in a nursery 1kg of seed can produce 32,000 seedlings. This would save the farm approximately KES 10,000.

2. Timing: is important and will determine how many of the seeds germinate. If the seed is planted and the rains delays, the seed lose viability and the germination is poor. A poor stand will result in low fodder yield and might need gaping. When seedlings are used, they are planted at the on-set of rain and seedling survival is improved. The stand is better and hence better forage yields are obtained.

A number of youth in Bungoma and Siaya are already selling seedlings to farmers who need to establish bracharia pastures. The nursery business was evaluated based on the available data from the youth in Siaya. The cost of producing 20,000 seedlings is KES 19,000 translating to about KES 0.95 per seedling (Table 13).

Table 13: Cost of Production of Bracharia Seedlings in Western Kenya

| Activity/Item | Units Required | Unit Cost | Cost (KES) |
|---|---|---|---|
| Land preparation (Manday) | 8 | 250 | 2,000.00 |
| Planting labour | 8 | 250 | 2,000.00 |
| Irrigation (water and labour) | 20 | 250 | 5,000.00 |
| Seed (Kg) | 1 | 5,000.00 | 5,000.00 |
| Weeding (Mandays) | 4 | 250 | 1,000.00 |
| Manure (20 wheelbarrows) | 20 | 200 | 4,000.00 |
| Total Cost | | | 19,000.00 |

A kilogramme of Mulato II seed will have approximately 40,000 seeds. At 85% germination rate a kilogramme of seed will produce about 34,000 seedlings. These seedlings are sold for between KES 3-5. Therefore, from 1kg of seed the produced seedlings will give a revenue of KES 102,000 – 170,000. The seedlings can be produced twice a year targeting the two rain seasons win western Kenya. The GM for the Bracharia seedling business is 90.7% (Table 14) and the first livelihood change from poor to emerging at 2.37 kg of seed where the per capita income would be KES 200. The income gets to lower and upper middle incomes at 3.4 kg and 5.94 kg of seed respectively.

## Forage production and on farm feeding of the produced forages

Proper feeding is identified as one of the most limiting factors in dairy production, several reports describe the feeding situation on many farms in Kenya as insufficient in quantity and quality resulting in underfed dairy cows, which such reach out only to a limited percentage of their production potential.

Cows require 50-60 kg (even up to 80 kg for a 400 kg cow)of high quality of fresh feed/day to be healthy and productive. Most of the cows do not get this quantity, nor is the quality of the feed provided, meeting their nutritional requirements. Dried maize stokes, overaged Napier or low quality hay are frequent feeds and the productivity of the cows is consequently low. Production of forages can change the situation towards the better. Farmers planting forages and feeding them to their cows report on significant increased milk productivity.

Consultants of the Dutch Senior expert service recommend to feed dairy cows ideally on fresh high quality forage as this is ideal for the intake, digestibility and productivity of the cows.

On farm produced forage is also a way to bring down costs, which is important as feeding accounts for 60 – 70 % of the costs in dairy production. If the dairy farmer finds a way to bring down this cost factor, the production of milk will becomes more economic and the profitability of the farm will increase.

Conclusion:

- on farm forage production is increasing the quantity and quality of the available feed.
- feeding forages to the cows is increasing their milk production
- producing own forage brings down feeding costs

**Production of forages and land size needed to feed one cow**

If a dairy cow is exclusively fed on fresh forage:

Need of forage /cow / year: 50-60 kg / cow / day x 365 =18.250 – 21,900 kg /cow /year

Average 55 kg /cow/day x 365 = 20,075 kg /cow / year

Need of land:

Table 1: Example1; production data from Magut and Leketeton farms (Eldoret) for fresh forage

| Forage (fresh) | Prod kg FM /ha/year | Prod/year : 20 t = numbers of cows fed /ha | Need of land to feed 1 cow exclusively on fresh forage |
|---|---|---|---|
| Brachiaria Mulato2 | 40 t | 40t : 20 t/cow=2 | 0.5 ha |
| Brachiaria Cayman | 51 t | 51t : 20 t/cow=2,5 | 0.4 ha |
| Panicum Mombasa | 50 t | 50t : 20 t/cow=2,5 | 0.4 ha |

If a dairy cow is exclusively fed on dry matter (hay)

Need of kg DM / cow / day: 12 -15 kg depending on the body weight of the cow

Need of kg DM / cow / year: Average 13.5 kg / cow / day x 365 = 4927 kg

Table 2: Example2; production data from Kagura ATC and Chure dairy from trials on cutting regime for dry matter. In brackets production range

| Forage | Prod kg DM/ha/year (range) | Prod / year : 4,92t/year/cow= number of cows fed/ha | Need of land to feed 1 cow exclusively on |
|---|---|---|---|
| Brachiaria Basilisk | 17.84 (15,24 – 20.46) | 17,84 : 4,92 = 3.62 | 0.276 ha |
| Brachiaria Cayman | 23.52 (18.62 – 28.42 | 23.52 : 4.92 = 4.78 | 0.209 ha |
| Panicum Mombasa | 16.54 (10.61 – 22.46) | 16.54 : 4.92 = 3.36 | 0.298 ha |

Remark: Many farmers in the Meru area favour Panicum Mombassa and Panicum Tanzania due to the high biomass production. This is not reflected in the above productivity numbers and leaves some questions open and has to be further assessed.

**Increase of productivity per cow after changement of feeding to a stronger forage based diet**

Table 3: Four examples of increasement of milk production based on interviews with farmers in the Meru area. All the farmers interviewed have high potential exotic breeds, mainly Frisian and Holstein

| Farmer (names known to the author) | Cows total (milking cows) | Average prod of cows before | Average prod of cows after | Increase average per cow in l (%) | Increase in income / cow /year (KES)* | Total income from milk sales/year (KES) |
|---|---|---|---|---|---|---|
| No 1 | 11 (4) | (8-9 l) | 20 l (T: 80 l) | 11 l (122 %) | 3305 l / cow 114.070 (T: 456.000) | 829.600 |
| No 2 | 29 (12) | 18 l (total 212 l) | 24 l (T: 300 l ) | 6 l (33 %) | 1830 l / cow 62.220 (T: 746.640) | 3.111.000 |
| No 3 | 5 (2) | 15 l | 18 l | 3 l (20 %) | 915 l / cow 31.110 (T: 62.220) | 373.320 |
| No 4 | 15 (6) | 13 l (T: 40 l – from 3 cows) | 26 l (T: 160 l – from 6 cows) | 13 l (100 %) | 3965 l / cow 134.810 (T: 808.860) | 1.659.200 |

*Lactation period: 305 days/year, price per l of milk 34 KES

Establishment cost for one ha of forages based on 20 farms from our Cost-Benefit Analysis (Virginia Mwangi, 2019) and info received from Climate smart Brachiaria Project.

Establishment cost for one ha of forages is about 110.000 KES. Based on experiences from South and Latin America forage plots can be harvested for at least 10 years without decrease of yield. Colleagues from CIAT's Tropical Forages have even seen forages plots used for more than 20 years without reestablishment.

Calculating a time of use of 10 years the cost per year are 11.000 KES/ha for establishment.

Yearly maintenance costs for the plots are calculated on a basis of 20 farmers interviewed for the cost benefit analysis. The average costs for maintenance / ha / year was calculated with 149.000 KES. This number is highly doubtable even that it is based on farmer interviews. Maintenance costs cannot be higher as the establishment costs; as costs for land preparation, seeds, planting and more intensive weeding do only account in the first year, while manure application and harvesting costs are the main cost factors from year two on.

The origin forms show that e.g.

- Farmer No 5 applied 36.000 kg wet manure on 2 acres, which translates to about 4.4 kg / m2, doubts are justified, if that is realistic. In addition, the value of 10 KES / kg of wet manure seems to be overestimated. A value of 3 KES / kg of dry manure seems to be the more realistic price (info from CIAT's long term trial responsible, 2019)

- Farmer No 6 applied 360 kg of dry manure on ¼ acre, which translates to 0.360 kg / m2. The involved labor costs are 6 hours, which seems to be realistic, while 30 days each for harvesting 1000 m2 is not possible.

- Another farmer claimed having applied a quantity of manure, which would represent an amount of 40 kg of dry manure / m2, which is far from being realistic.

- There are more such examples, though we have to estimate the costs for maintenance; taking harvest costs and manure application as the main cost factors, the yearly maintenance cost can be estimated at maximum 50.000 KES/ ha / year. That gives a realistic cost of 61.000 KES / ha forage / year.

Table 4: Profit per cow / year calculated for four commercial oriented farmers in the Meru area based on the productivity data for forages from Table 1 and 2 and the increase in milk productivity by a stronger forage oriented feeding

| Farmer | Forage necessary to feed 1 cow / year | Prod cost forage / year / cow | Additional income from higher milk production / year / cow | Profit per cow / year |
|---|---|---|---|---|
| Farmer No 1 | Br. Basilisk<br>0.34 ha | 61,000 x 0.34<br>20,740 KES | 114,000 | 93,260 KES |
| | Br. Cayman<br>0.30 ha | 61,000 x 0.30<br>18,300 KES | 114,000 | 95,700 KES |
| | Br. Mulato 2<br>0.5 ha | 61,000 x 0.5<br>30,500 KES | 114,000 | 84,000 KES |
| | P. Mombasa<br>0.30 ha | 61,000 x 0.30<br>18,300 KES | 114,000 | 95,700 KES |

| Farmer | Forage necessary to feed 1 cow / year | Prod cost forage / year / cow | Additional income from higher milk production / year / cow | Profit per cow / year |
|---|---|---|---|---|
| Farmer No 2 | Br. Basilisk 0.34 ha | 20,740 KES | 62,200 | 41,460 KES |
| | Br. Cayman 0.30 ha | 18,300 KES | 62,200 | 43,900 KES |
| | Br. Mulato 2 0.5 ha | 30,500 KES | 62,200 | 31,700 KES |
| | P. Mombasa 0.30 ha | 18,300 KES | 62,200 | 43,900 KES |

| Farmer | Forage necessary to feed 1 cow / year | Prod cost forage / year / cow | Additional income from higher milk production / year /cow | Profit per cow / year |
|---|---|---|---|---|
| Farmer No 3 | Br. Basilisk 0.34 ha | 20,740 KES | 31,100 KES | 10,360 KES |
| | Br. Cayman 0.30 ha | 18,300 KES | 31,100 KES | 12,800 KES |
| | Br. Mulato 2 0.50 ha | 30,500 KES | 31,100 KES | 600 KES |
| | P. Mombasa 0.30 ha | 18,300 KES | 31,100 KES | 12,800 KES |

| Farmer | Forage necessary to feed 1 cow / year | Prod costs forage / year / cow | Additional income from higher milk production / year / cow | Profit per cow / year |
|---|---|---|---|---|
| Farmer No 4 | Br. Basilisk 0.34 ha | 20.740 KES | 134,810 KES | 114,070 KES |
| | Br. Cayman 0.30 ha | 18.300 KES | 134,810 KES | 116,510 KES |
| | Br. Mulato 2 0.50 ha | 30.500 KES | 134,810 KES | 104,310 KES |
| | P. Mombasa 0.30 ha | 18.300 KES | 143,810 KES | 116,510 KES |

This description of a business case is not claiming to be scientific; it is based on forage production measurement from four different sites in Meru and Eldoret undertaken over six respective 12 months. As productivity of forages depends on many factors like soil quality, natural rainfall patterns, altitude but also on forage management like fertilizer / manure application, cutting regime or additional irrigation, it is impossible to give exact predictions about harvests for a specific site.

The quantity of forage production is highly dependent on the environment and the management of the plots and the potential is high and profitable.

In the described business case, the forage is fed on farm to the dairy cows and increased in all cases the productivity of the dairy cows. It is known that the productivity of cows depends on many factors. Genetic potential, health, cow comfort are important, but the most important influence is given by the feeding. The above calculations are made under the estimation that all other influencing factors were kept stable and that the cows are entirely fed on forages. In reality the diet is composed of different origins (Napier, sweet potato vines, Rhodes grass hay, silage) but all interviewed farmers reported the above noted productivity increases since the improved forages are more dominant in the feeding of their cows. It can be estimated that also local breads fed on forages will increase their productivity, but if it will be profitable will depend on the increase of the milk yield versus forage production costs, but all feeding is expensive and it would be interesting to compare other feeding costs to self-produced forage.

Conclusion: Even without referring to concrete numbers, all the farmers increased their profit per cow. The increase however differs, but the greater picture is that producing and feeding fresh forage to dairy cows has in general a positive effect and can be recommended to farmers.

**Forage growing for commercial purpose, hay production**

Forage production for commercial use is a model for people who are not able or do not want to invest in dairy production, but are looking for a crop which is relatively easy to cultivate and for which a market already exists.

It is also a possibility to start on a small area with small investments to gather experience and gradually expand once the grower is more confident with the production and marketing the product. In Western Kenya, forages are often sold fresh due to the bad reputation of hay, but Brachiaria can be dried well and transformed to high quality hay, making it a storable product that can be sold in times of higher demand and prices, like the dry season.

Case 1

In Western Kenya, young people have started small-scale productions using different Brachiaria (Hybrids and cvs) for commercial hay production. Info on these groups and data is taken from a report commissioned by GfA for the Green Innovation Center (Fodder value chain analysis in Western Kenya: Opportunities for Business development, David Miano Mwangi and Eunice Onyango, 2019)

Table 1: Cost of Production of Bracharia Hay in Western Kenya (Establishment Phase)

| Activity/Item | Unit Cost (KES) | Units | Total Cost |
|---|---|---|---|
| 1st Ploughing | 3,000 | 1 | 3,000 |
| 2nd Ploughing | 3,000 | 1 | 3,000 |
| Harrowing | 2,500 | 1 | 2,500 |
| Seedlings | 3 | 32,000 | 96,000 |
| DAP (2 x 50 kg bags) | 3,500 | 2 | 7,000 |
| Planting | 300 | 12 | 3,600 |
| Weeding | 300 | 12 | 3,600 |
| Harvesting and baling (Per bale) | 70 | 740 | 51,800 |
| Labour for transporting to store (Man days) | 20 | 300 | 6,000 |
| Total | | | 176,500 |

Table 2: Cost of Production for Brachiaria Hay Production in Western Kenya (Maintenance Phase)

| Activity | Unit Cost (KES) | Units | Total Cost |
|---|---|---|---|
| Top dressing (1.5*50 kg bag CAN) | 2,200 | 2 | 3,300 |
| Labour for applying CAN (Man days) | 4 | 300 | 1,200 |
| Labour transporting | 20 | 300 | 6,000 |
| Harvesting | 70 | 740 | 51,800 |
| Total Cost (KES) | | | 62,300 |

Mwangi / Onyango use a production of 10.000 kg DM/year that translates to 666 hay bales of 15 kg. The price of Brachiaria hay is given with 400 KES/Bale.

Using this production figure a turnover of 266,400 can be realized.

All the data given for case 1 are calculated per acre, to compare it to other case which are calculated per ha the numbers have to be multiplied by 2,5 which presents

Table 1.1. Cost of establishment of Brachiaria in Western Kenya/ha if bought seedlings are used

| Activity/Item | Unit Cost (KES) | Units | Total Cost |
|---|---|---|---|
| Total | | | 156,350 |

Establishment costs for Brachiaria plots used over 10 years 15,635 KES/year

Yearly maintenance cost (fertilisation, harvest, transport) 155,750 KES/year

Yearly cost per ha Brachiaria 171,385 KES/year

Table 1.2. Cost of establishment of Brachiaria in Western Kenya /ha if seeds are used

| Activity / Item | Unit Cost (KES) | Units | Total cost |
|---|---|---|---|
| 1st ploughing | 7500 | 1 | 7,500 |
| 2nd ploughing | 7500 | 1 | 7,500 |
| Harrowing | 6250 | 1 | 6,250 |
| Seed costs | 5000 | 8 | 40,000 |
| DAP (5 x 50 kg) | 3500 | 5 | 17,500 |
| Seeding | 300 | 12 | 3,600 |
| Weeding | 300 | 36 | 10,800 |
| Total | | | 100,350 |

Establishment costs for Brachiaria plots used over 10 years 10,350 KES/year

Yearly maintenance cost (fertilisation, harvest, transport) 155,750 KES/year

Yearly cost per ha Brachiaria 166,100 KES/year

Establishment costs for Brachiaria plots are about 1/6 of the maintenance costs, it is also a negligible difference between direct establishment by seeds or establishment by seedlings, as establishment costs have to be seen as a cost factor for 10 years. However, the initial investment differs and with seedlings, it is 50% higher.

Table 3: Cost benefit calculation for different Brachiaria from year 2 on (planted with seedlings)

| Brachiaria | Prod cost per ha /year | Prod in t DM / ha / year | Value of prod / ha / year (KES) | Income – Prod cost = Profit (KES) |
|---|---|---|---|---|
| Not specified by Mwangi/Onyango | 171,385 KES | 25.00 * | 400,000 | 228,615 |
| Mulato 2 | 171,385 KES | 8.00 ** | 213,000 | 41,615 |
| Cayman | 171,385 KES | 23.52 *** | 627,200 | 455,815 |
| Cayman | 171,385 KES | 10.20 **** | 272,000 | 100,615 |
| Basilisk | 171,385 KES | 17.84 ***** | 475,730 | 304,345 |

production life of 10 years is base for the calculation (source: CIAT Tropical Forages)

*production data from literature, most possible they are too optimistic, especially when compared to measured production (see below)

**production data from 2 farms in Eldoret

***production data from cutting regime trials on 2 sites in Meru

****production data from 2 farms in Eldoret

*****production data from cutting regime trials on 2 sites in Meru

Value calculated on the base of 15 kg hay bales valued at 400 KES/bale (Mwangi, Onyango, 2019)

The profit of hay production depends on many factors and the sales price is very important. This sales price varies from area to area and is also underlying seasonal effects. If a producer has got the possibility to store his hay and sell it while dry season for a higher price that can be interesting, but always keep in mind that storage is not for free and also demands for investments.

**Artisanal silage making through 'service provider enterprises' in Kenya**

Introduction

Feed is key for the success of dairy farmers. The productivity of dairy cows in Kenya varies enormously between 1.5 l – 25 l per cow and day. There are different factors that influence the productivity of dairy cows, like the genetics (exotic breeds or cross breeds) or the quantity and quality of the fodder they get. A cow consumes about 50-80 KG of fresh fodder per day and the feeding costs represent about 75 % of the costs for dairy farmers, which shows that the provision of feed is a key factor in keeping dairy cows.

Research shows that the availability of feed depends a lot on the season. In the rainy season, there is normally sufficient animal feed available. Depending on the production scheme the animals are grazed on own or public land or held in sheds and fed there (cut and carry system).

While the dry season availability of fodder is dramatically different, especially for smallholder dairy farmers which own between 2-4 cows and work on an average farm size of up to 2 acres, scarcity of available fodder is frequent. Forage production and conservation is still an exception on most of the small-scale farms, though farmers depend on buying in fodder from commercial fodder and feed producers. The prices for hay in the dry season go up to 220 KES/16-20 kg bale of Rhodes Grass Hay and up to 360 KES for better quality Lucerne Hay. Silage packs of 25 kg are sold at 250 KES.

The high prices for bought in fodder and feed often indicate a not sufficient feeding practice for the animals which 'just survive' and react with a productivity tending to '0'.

Apart of hay making, silage making is another possibility of conserving fodder for the time of scarcity. Silage making is labour intensive and has to be done properly. Different available plant material can be transformed into silage like maize, sorghum, Napier grass, Brachiaria grass, Panicum grass or residues from sweet potatoes or beans. As most of the farmers lack skills and labour force for silage production, there come in the service provider enterprises (SPE).

Service provider enterprises for silage making:

The idea of service delivery for silage making is already practiced in Kenya, namely by a group of 7 young man, based in Meru county (northeast of Mount Kenya)

The group, as more than 20 others, was trained by SNV's Kenya Market led Dairy Project in growing quality fodder, make silage, manage dairy feed and preserve animal feed.

Since then, they are offering their services to farmers in silage making (mainly maize silage).

The offered service consists in:

Preparation of the silage bunker and placement of a polyethylene sheet.

Chopping the raw material.

Bringing the material into the bunker in layers.

Adding a molasses-water mixture and compacting each layer before the next layer is added.

Once the silage pit / bunker is filled, the bunker is closed to prevent air contact of the silage material, which has to undergo a process of anaerobic fermentation.

Covering the silage material and cover it with a layer of soil for permanent pressure and to keep the air out to guarantee a proper fermentation.

Capacity of the 7 person group: up to 700 tons/month at the cost of 1KES /kg

Average income of the group members: 40000 KES/month

Needed investments:

| | |
|---|---|
| Forage chopper (price range for self-propelled machines) | 30.000 (light duty)-170.000(heavy d.) KES |
| Forage chopper (tractor driven) | 600.000 – 2.000.000 |
| Shovels, forks, wheel barrows (x6) | 48.000 |
| 7 pairs of wellingtons | 14.000 |
| Other small material | 10.000 |

(ev. training costs, if not coming from a dev. Partner)

Data that are more detailed have to be collected in field studies.

Silage making is mainly practiced at the end of the cropping seasons when the maize is ready for harvesting, though it is a seasonal occupation, which does not provide occupation and income over the whole year, but however offers occupation and income generation for parts of the year.

Expanding the silage making services to other types of silage like grass silage (Napier, Brachiaria and Panicum) could offer a more permanent demand for silage services, but up to now the production of forages is not so big that forages are mostly fed fresh or in some scarce cases farmers make hay out of Brachiaria.

This business case is actually practiced in the area east of Mount Kenya and from there down to Thika. CIAT is also in contact with a local company (development oriented) which is engaged in silage making and silage making training in Central Kenya. I am convinced that there is a lot of potential for silage making as one measure to mitigate effects of drought periods, which go along with fodder scarcity and a dramatic decrease of milk production. Especially in the areas with more rainfall and higher air moisture, silage making is a good alternative to hay making. Though the intensive agriculture areas of Western Kenya should be focused for scaling.

The above-described approach is economically interesting for medium scale farmers.

Based on the rainfall patterns and the variable fodder availabilities, farmers should be prepared to bridge different length of fodder scarcity periods. In the Western Highlands of Kenya, this period is about 2.5 months. Based on that estimation and knowing that a cow needs about 30 kg of silage per day to keep up a high productivity, it is easy to calculate the amount of silage, which a farm should produce, and store:

Need of silage fodder on the example of a farmer having 10 cows

| | | |
|---|---|---|
| 30kg silage x 10 cows | need per day: | 300 kg |
| 300 kg/day x 30 days | need per month: | 9000 kg |
| 300 kg/day x 75 days | need for 2.5 months: | 22500 kg |

As the kg of maize silage is sold at 10 KES/kg that would represent costs of 225.000 KES (calculated based on the price of packed bricks). We found no information of prices for big quantities. To be verified, but for sure that will be cheaper!

For small-scale farmers the situation presents in a different way: small-scale farmers often only have 1-3 cows and neither the financement nor the space to store bigger quantities of silage. But also for them silage making is interesting to gap the fodder scarcity periods.

The possibilities are divers and

1) Silage can be prepared in pits of 2x2x1 m, which can take up to 1000 kg of chopped fresh material. The other material needed is about 20sqm of polyethylene sheet and 1-2 litres of Molasses. (This approach is recommended by 'farmerstrend' and can be done by the farmers or be part of a service package of the service providers.

One of these units will feed a cow for more than a month if the silage is the only fodder provided. For a period of 2.5 months, two of such described units should be sufficient.

2) Silage preparation in plastic bags/tubes etc.

The existing SPEs were trained by SNV and mainly established within Dairy cooperatives around Meru and Eldoret.

The SPE approach has got a potential for job creation in the rural areas and could be brought to other areas of Kenya, especially to areas which do not offer the best conditions for hay making

| | |
|---|---|
| Target group | small scale and medium farmers as customers |
| | Youth groups which are trained for delivering the service |
| Product | silage making services |
| Costs | 1 KES/ kg (costs for the customer) |
| Investment | 1 week training in silage making for the group members |
| | (financement through donors or dairy cooperatives) |
| | Equipment for the service provider enterprise |
| | (could be prefinanced by Dairy cooperatives, loan schemes, rural banks) |

Success factors

- Trained groups offer the service
- The services are of good quality and affordable for the customers
- Dairy farmers book the services and are satisfied with the service delivery
- Service delivery becomes part of the system

**Tutorial videos**

To visualize some of the information we have produced videos together with Mediae, the producer of Shamba shape up. The episodes as well as the tutorial videos are accessible by the below link.

7 tutorial videos on forage production, management and use

1. Sustainable livestock production
2. Planting from seeds
3. Planting from cuttings and splits
4. Harvesting (and conservation)
5. Pest and disease control
6. Feeding budget and planning
7. Forage production summery

Every video is available in English and Kiswahili:

https://www.youtube.com/playlist?list=PLuldN-hq8sqklxp03SSBK-84QK7AG_yfK

# *Crotalaria juncea*

**Common names:** Crescent Sunn / Sunn Hemp

**Crotolaria juncea *belongs to the legume family which has a dual use as a green manure and as a forage. It is not very demanding in terms of soil quality, but gives a better yield in sandy soils. Water requirements are not very high. Suitable for grazing, hay, silage and fresh in feeding trough (cut and carry).***

## Characteristics

**Palatability:** excellent
**Crude protein potential:** high
**Water requirements:** low
**Planting density:** 35-40 kg/ha (14-16 kg/acre) for green manure
50 kg/ha (20 kg/acre) for forage production
**Planting depth:** 1-2 cm
**Time to harvest after establishment** 6-8 weeks
**Time to incorporate in the soil green manure** 6-8 weeks
**Production potential:** 25-30 tons green matter (5-7 tons dry matter)
**Soil requirements:** filtering and or well drained soils
**Adaptability to soils with pH:** neutral to slightly acid soils (pH 7 – pH 5.5) for best results
**Frost sensitivity:** Avoid higher altitudes with risk of frost. Frost will cause total loss. Low temperatures also hamper a proper growth

## Land Preparation

- Is not very demanding in terms of soil quality, but gives better yield in sandy soil, as it prefers filtering and well-drained soils.
- Prepare a good seedbed of fine structure free of weeds. After sowing, roll to compact the soil to compact the soil and ensure a good soil – seed contact.

## Establishment

- We recommend planting in rows, 40-50 cm apart, 10-12.5 cm distance in the rows (8-10 seeds per meter.
- When manually planted, step on the planting hole to create a close contact between seeds and soil.
- For drilling through seed drills, e.g. a sorghum planter, calibrated to 8-10 seeds per linear meter, be very careful not to bury the seed more than 1-2 cm in depth.
- Roller drills are preferred because they do not bury the seed too deeply, but instead press the seed just below the soil surface.
- For broadcast sowings, seed can be spread mechanically or hand sown. The seed must be covered after sowing by harrows. On small areas, tree branches or large brooms can be used to lightly cover the seeds with soil. Be careful not to bury the seed more than 1-2 cm under the soil. Seeding can be started after 30 mm of rainfall.
- Assure a good soil – seed contact which is key for good germination, either by stepping on the planted seeds or by compacting the soil with a roller after planting.

## Fertilization

- Crotolaria does not demand fertilization. It is a legume with the capacity to fix as much as 50-60 kg nitrogen (a maximum of up to 83 kg N was reported) per ha and production cycle if the plants are incorporated entirely in the soil.
- If harvested as forage the remaining nitrogen quantities are lower but still have a positive effect on following crops.

## Management

**As green manure:**

- 6-8 weeks after establishment, incorporate the plants in the soil. Incorporation of green matter in the soil plays an important role in maintaining or increasing soil fertility, improves the structure and porosity of the soil, stimulates biological activity and creates a better availability of nutrients.
- Another advantage of Crotolaria is it's nematicide effect. It reduces soil nematodes (parasites) and thus improves crop yields

**As forage:**

- Crotolaria Sunn Hemp produces good quality forage with a good protein content. It provides 5-7 tons dry matter per cut per hectare in a 6-8 weeks cycle.
- It is recommended to harvest at the beginning of flowering when 10% of the plants are in bloom to receive the best balance of quantity and quality.
- The forage is highly palatable and very well consumed by cattle, goats and sheep. It also can be used to produce hay or silage.
- Care should be taken to minimize leaf loss during mowing and harvesting as leaves are richer in crude protein than stems

## Acknowledgements

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# *Panicum maximum* cv. Mombasa

***Originally from Tanzania, grows up to 2 m tall building space taking tussocks with large leaves measuring about 3 cm wide and 97 cm long. The leaves are erect, breaking at the tips and are pubescent. Stems do not have hair or wax. Similar to Hybrid Napier grass in habit, but more leafy. Suitable for grazing, silage and fresh in feeding trough. Not suitable for haying due to its difficult drying characteristics. The forage quality is excellent.***

## Characteristics

| | |
|---|---|
| **Palatability** | good |
| **Digestibility** | **good** |
| **Crude protein potential** | 8–14 % (depending on soil fertility) |
| **Tolerance to water logging** | low |
| **Tolerance to drought** | good (Tropical seeds), low (SOEST) |
| **Tolerance to shade** | good |
| **Water requirement** | min. 800 mm/year |
| **Planting density** | 4–5 kg/ha |
| **Planting depth** | 1(-2) cm |
| **Germination** | 10–28 days |
| **Days to first cut** | 75–100 days |
| **Time in rotation** | 40–45 days |
| **Plant height** | 200 cm |
| **Production potential** | 20–40 t Dry matter/ha/year |
| **Sol fertility requirements** | high |
| **Adaptability to soils with acid ph.** | ? |

## Seedbed preparation

- *Panicum* would require a well-prepared seedbed. Due to the small seeds, a fine seed would be preferable.
- As for most crops, seedbed preparation should be done well before the rains for ease of preparation and killing of weeds.
- If the piece of land is prone to obnoxious weeds, e.g. couch grass, herbicide spraying is advisable to systematically control these weeds.
- Plough to about 25 cm depth and harrow the land to obtain a fine soil tilts necessary for seeds that are small.
- Preferably avoid sloping and uneven land for lay the plots and minimize likely variations in performance.

## Establishment

- Can be either planted in rows, 50 cm apart (4kg/ha), or broadcasted sown at 6–8 kg/ha.
- For broadcast sowing, seed can be spread mechanically or hand sown.
- Sow the seed on to the soil surface, brush the seed with soil by using tree branches or large brooms.
- Bury the seed no more than 1–2 cm under the soil.
- It is easy to plant from rooted tillers, but due to its labour intensity is only an option for smaller plots.
- Seeding / planting can be started after 30 mm of rainfall.

## Fertilisation

- After fertilizer application during planting (for the initial fertilization use a phosphorus dominated fertilizer to support root development – DAP), subsequent applications should be annually with nitrogenous fertilizer at a rate of 100 kg/ha of calcium ammonium nitrate (CAN).
- Preferably, application should be after harvesting and when the soils are wet enough to dissolve the fertilizer. Best harvest results will be realized by fertilizing 60 kg N / ha after each harvest.

## Management

- *Panicum* will take 75–100 days till the first cut. In rotation the following cuts can be done after 40–45 days.


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# *Brachiaria hybrid* cv. Mulato II

*Brachiaria ruziziensis* × *B. decumbens* × *B. brizantha*

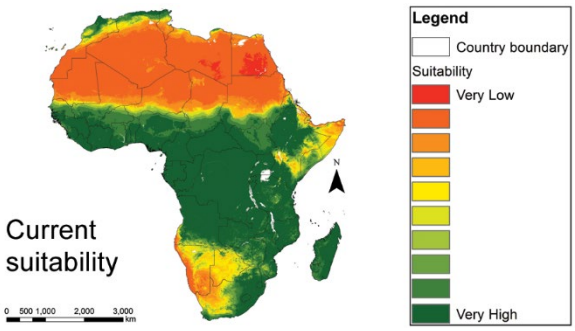
***Mulato II is a leafy, vigorous, semi-decumbent perennial grass of medium height, growing to between 80–100 cm without inflorescences. It is a very leafy plant with 5–8 leaves (length 40–60 cm, width 0.6–0.7 cm) per stem. The intense green leaves are strongly pubescent on both sides of the leaves. Pubescens on the cylindrical stems is weak. It is recommended for regions with acid soils of medium to low fertility, prolonged periods of drought, high temperatures.***

## Characteristics

| | |
|---|---|
| **Palatability** | high |
| **Digestibility** | high |
| **Crude protein potential** | up to 18% (depending on the soil quality) |
| **Tolerance to water logging** | poor |
| **Tolerance to drought** | good |
| **Tolerance to shade** | poor |
| **Water requirement** | min. 800 mm/year |
| **Planting density** | 8–10 kg/ha, zero tillage |
| **Planting depth** | 2 cm |
| **Germination** | 7–21 days |
| **Days to first cut** | 70–80 days |
| **Time in rotation** | 25–45 days (wet season) 60–70 days (dry season) |
| **Plant height** | 80–100 cm |
| **Production potential** | on low fertile land (ph. 4.7) 14–17 t dry matter/ha/year. On high fertile soils (ph. 6.3) up to 35 t dry matter/ha/year |
| **Sol fertility requirements** | medium to high |
| **Adaptability to soils with acid ph.** | high |
| **Resistance to spittlebug attack** | high |

## Seedbed preparation

- *Brachiaria* would require a well prepared seed bed. Due to the small seeds, a fine seedbed would be preferable.
- As for most crops, seedbed preparation should be done well before the rains for ease of preparation and killing of weeds.
- If the piece of land is prone to obnoxious weeds, e.g. couch grass, herbicide spraying is advisable to systematically control these weeds.
- Plough to about 25 cm depth and harrow the land to obtain a fine soil tilth necessary for seeds that are small.
- Preferably avoid sloping and uneven land for lay the plots and minimize likely variations in performance.



## Establishment

- Can be either planted in rows, 40–50 cm apart (8 kg /ha), or broadcasted sown at 10–12 kg/ha.
- For drilling through seed drills, be very careful not to bury the seed more than 2 cm in depth.
- Roller drills are preferred because they do not bury the seed too deeply, but instead press the seed just below the soil surface.
- For broadcast sowings, seed can be spread mechanically or hand sown.
- The seed must be covered after sowing by harrows.
- On small areas, tree branches or large brooms can be used to lightly cover the seeds with soil.
- Be careful not to bury the seeds more than 1–2 cm under the soil.
- Seeding can be started after 30 mm of rainfall.

## Fertilisation

- After fertilizer application during planting (for the initial fertilization use a phosphorus dominated fertilizer to support root development – DAP), subsequent applications should be annually with nitrogenous fertilizer at a rate of 100 kg/ha of calcium ammonium nitrate (CAN).
- Application should be done after rains when the soils are wet enough to dissolve the fertilizer. Preferably, application should be after harvesting on wet soils to support the regrowth.

## Management

- *Brachiaria* will take 70–80 days till the first cut. In rotation the following cuts can be done after 25–45 days while rainy season, respectively 60–70 while dry season.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# *Brachiaria hybrid* cv. Cayman

*Brachiaria ruziziensis* × *B. decumbens* × *B. brizantha*

***A leafy, vigorous, semi-decumbent perennial grass of medium height, growing to between 80–110 cm without inflorescences. With a tillered growth habit, the Cayman grass produces abundant stolons. In addition in high moisture conditions, this grass modifies its growth habit and develops, early during its growth cycle, a large number of decumbent stems, which produce tillers and roots at the nodes. These superficial roots give the plant support, absorb nutrients and supply oxygen to the plant in these adverse conditions of poor drainage.***

## Characteristics

| | |
|---|---|
| **Palatability** | high |
| **Digestibility** | high |
| **Crude protein potential** | up to 17% (depending on the soil quality) |
| **Tolerance to water logging** | high |
| **Tolerance to drought** | good |
| **Tolerance to shade** | poor |
| **Water requirement** | min. 800 mm/year |
| **Planting density** | 8–10 kg/ha, zero tillage |
| **Planting depth** | 1-2 cm |
| **Germination** | 7–21 days |
| **Days to first cut** | 90–100 days |
| **Time in rotation** | 25–30 days (wet season) 60–70 days (dry season) |
| **Plant height** | 80–110 cm |
| **Production potential** | up to 15 t fresh material/ha every 10 weeks in rainy season |
| **Sol fertility requirements** | medium to high |
| **Adaptability to soils with acid ph.** | high |
| **Resistance to spittlebug attack** | high |

## Seedbed preparation

- *Brachiaria* would require a well prepared seed bed. Due to the small seeds, a fine seedbed would be preferable.
- As for most crops, seedbed preparation should be done well before the rains for ease of preparation and killing of weeds.
- If the piece of land is prone to obnoxious weeds, e.g. couch grass, herbicide spraying is advisable to systematically control these weeds.
- Plough to about 25 cm depth and harrow the land to obtain a fine soil tilts necessary for seeds that are small.
- Preferably avoid sloping and uneven land for lay the plots and minimize likely variations in performance.

## Establishment

- Can be either planted in rows, 40–50 cm apart (8 kg /ha), or broadcasted sown at 10–12 kg/ha.
- For drilling through seed drills, be very careful not to bury the seed more than 2 cm in depth.
- Roller drills are preferred because they do not bury the seed too deeply, but instead press the seed just below the soil surface.
- For broadcast sowings, seed can be spread mechanically or hand sown.
- The seed must be covered after sowing by harrows. On small areas, tree branches or

large brooms can be used to lightly cover the seeds with soil.

- Be careful not to bury the seeds more than 1–2 cm under the soil. Seeding can be started after 30 mm of rainfall.

## Fertilization

- After fertilizer application during planting (for the initial fertilization use a phosphorus dominated fertilizer to support root development – DAP), subsequent applications should be annually with nitrogenous fertilizer at a rate of 100 kg/ha of calcium ammonium nitrate (CAN).
- Application should be done after rains when the soils are wet enough to dissolve the fertilizer. Preferably, application should be after harvesting on wet soils to support the regrowth.

## Management

- *Brachiaria* will take 70–80 days till the first cut. In rotation the following cuts can be done after 25–45 days while rainy season, respectively 60–70 while dry season.


## Acknowledgements

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# *Brachiaria hybrid* cv. Camello

*Brachiaria ruziziensis* × *B. decumbens* × *B. brizantha*

***Brachiaria Hybrid Camello is a product of breeding by CIAT. This perennial grass was evaluated by Papalotla in Oaxaca, Mexico, showing excellent results in terms of water stress tolerance and decumbent (creeping) growth habit. Two characteristics that make it a viable option for sites characterized by scarce erratic precipitation.***

## Characteristics

**Palatability:** high
**Digestibility:** high (62%)
**Crude protein potential:** 14-16% (depending on the soil quality)
**Tolerance to water logging:** poor
**Tolerance to drought:** extremely good
**Minimum water requirement:** 450 mm / year
**Planting density:** 8 kg/ha (planted in lines) 10kg/ha (broadcasting)
**Planting depth:** 1-2 cm
**Germination:** 7-21 days
**Days to first cut after germination / time in rotation:** 80-100 days / 25-45 days (wet season), 60-70 days (dry season)
**Plant height:** 110 - 130 cm
**Production potential:** 27 – 30 t DM/ha/year
**Sol fertility requirements:** intermediate
**Adaptability to soils with ph:** 4.5-8

## Description

- Camello has bright green stems and leaves and is the only non pubescent (hairy) Brachiaria Hybrid to date.
- Its thin to medium thick stems present short internodes and its nodes have high rooting capacity.
- The leaf-stem ratio is high (70:30). Due to it's creeping character it gives a good soil coverage.
- The plants heights will reach 110-130 cm. This grass requires well-drained soils of medium fertility and qualifies for soils from pH 4.5 – 8.
- Tolerance to flooding is poor and areas with waterlogging risks should be avoided.
- Camello was specially bred for dry areas. The minimum water requirement given by Papalotla is 300 mm, however we recommend 450 mm in the moment.
- Suitable for grazing, hay, silage and fresh in feeding trough (cut and carry).

## Seedbed preparation

- *Brachiaria* would require a wel- prepared seed bed. Due to the small seeds, a fine seedbed would be preferable.
- As for most crops, seedbed preparation should be done well before the rains for ease of preparation and killing of weeds.
- If the piece of land is prone to obnoxious weeds, e.g. couch grass, herbicide spraying is advisable to systematically control these weeds.
- Plough to about 25 cm depth and harrow the land to obtain a fine soil structure necessary for seeds that are small.
- To avoid too deep planting or movement of seeds in deeper levels, preplanting soil preparation is recommended, either using a roller or by passing tires or a heavy log.
- Preferably, avoid sloping and uneven land for lay the plots and minimize likely variations in performance.

## Establishment

- Can be either planted in rows, 40-50 cm apart (8 kg /ha), 30 cm distance in the rows and 4-5 seeds per hole.
- When manually planted, step on the planting hole to create a close contact between seeds and soil.
- For drilling through seed drills, e.g. a sorghum planter, calibrated to 15-18 seeds per linear meter, be very careful not to bury the seed more than 1-2 cm in depth.
- Roller drills are preferred because they do not bury the seed too deeply, but instead press the seed just below the soil surface.
- For broadcast sowings, seed can be spread mechanically or hand sown. The seed must be covered after sowing by harrows.
- On small areas, tree branches or large brooms can be used to lightly cover the seeds with soil.
- Be careful not to bury the seed more than 1-2 cm under the soil. Seeding can be started after 30 mm of rainfall.

## Fertilization

- After fertilizer application during planting (for the initial fertilization use a phosphorus dominated fertilizer to support root development – DAP at a rate of 100 kg/ha), subsequent applications (top dressing) should be annually with nitrogenous fertilizer at a rate of 100 kg/ha of calcium ammonium nitrate (CAN).
- Application should be done after rains when the soils is wet enough to dissolve the fertilizer. Preferably, application should be after harvesting.

## Management

- Camello will take 80-100 days before the first cut. In rotation, the following cuts can be done after 25-45 days while rainy season respectively 60-70 while dry season.
- Best harvest time is when the grass starts to develop flowers. Never let the grass develop flowers or even seeds, which are of low quality and hardly germinate.


## Acknowledgements

“This factsheet was developed with funding from Dutch government (NOW) through the project “Feed and Forage Seed Business Models to support further professionalisation of the dairy sector in Kenya and Uganda”, registered under W 08.240.106, coordinated by KIT Royal Tropical institute and implemented by the Alliance of Bioversity International and CIAT, ILRI and NaLIRRI.”

# *Brachiaria hybrid* cv. Cobra

*Brachiaria ruziziensis* × *B. decumbens* × *B. brizantha*

*Photo: Tropical Seeds, LLC.*

***Unlike Mulato II and Cayman, has an erect growth habit with well-defined tussocks, which is ideal for cut and carry. This type of growth allows it to quickly recover from both cutting and grazing. Results from trials undertaken in Mexico and Costa Rica indicated that dry matter production increases when cutting is conducted at 30–45 days. Cobra's advantage over other cut and carry forages is that it not only produces a great amount of forage with high protein content, but also presents high digestibility (69%) and palatability as it stays tender, even when mature.***

## Characteristics

| | |
|---|---|
| **Palatability** | high |
| **Digestibility** | high (69%) |
| **Crude protein potential** | up to 17% (depending on the soil quality) |
| **Tolerance to water logging** | low |
| **Tolerance to drought** | good |
| **Tolerance to shade** | poor |
| **Water requirement** | min. 800 mm/year |
| **Planting density** | 8–10 kg/ha, zero tillage |
| **Planting depth** | 2 cm |
| **Germination** | 7–21 days |
| **Days to first cut** | 90 days |
| **Time in rotation** | 30–45 days (wet season), 75 days (dry season) |
| **Plant height** | ? |
| **Production potential** | on medium to fertile soils > 20 t dry matter/hectare/year |
| **Sol fertility requirements** | medium to high |
| **Adaptability to soils with acid ph.** | high |
| **Resistance to spittlebug attack** | high |

## Seedbed preparation

- *Brachiaria* would require a well prepared seed bed. Due to the small seeds, a fine seedbed would be preferable.
- As for most crops, seedbed preparation should be done well before the rains for ease of preparation and killing of weeds.
- If the piece of land is prone to obnoxious weeds, e.g. couch grass, herbicide spraying is advisable to systematically control these weeds.
- Plough to about 25 cm depth and harrow the land to obtain a fine soil tilth necessary for seeds that are small.
- Preferably avoid sloping and uneven land for lay the plots and minimize likely variations in performance.

## Establishment

- Can be either planted in rows, 40–50 cm apart (8 kg /ha), or broadcasted sown at 10–12 kg/ha.
- For drilling through seed drills, be very careful not to bury the seed more than 2 cm in depth.
- Roller drills are preferred because they do not bury the seed too deeply, but instead press the seed just below the soil surface.
- For broadcast sowings, seed can be spread mechanically or hand sown.

- The seed must be covered after sowing by harrows. On small areas, tree branches or large brooms can be used to lightly cover the seeds with soil.
- Be careful not to bury the seeds more than 1–2 cm under the soil. Seeding can be started after 30 mm of rainfall.

### Fertilisation

- After fertilizer application during planting (for the initial fertilization use a phosphorus dominated fertilizer to support root development – DAP), subsequent applications should be annually with nitrogenous fertilizer at a rate of 100 kg/ha of calcium ammonium nitrate (CAN).
- Application should be done after rains when the soils are wet enough to dissolve the fertilizer. Preferably, application should be after harvesting on wet soils to support the regrowth.

### Management

- *Brachiaria* Cobra will take ~ 90 days till the first cut. In rotation the following cuts can be done after 30–45 days while rainy season, respectively 75 while dry season.


### Acknowledgements

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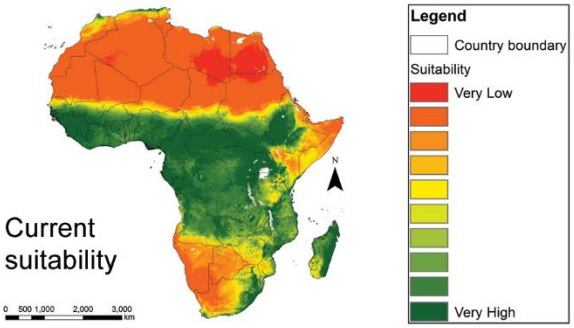
# *Brachiaria decumbens* cv. Basilisk




***Originally from Equatorial Africa, Basilisk was part of the 'Climate Smart Brachiaria Program' (Kenya) and selected one of four best performing Brachiaria by a participatory evaluation. It stands 0.6 to 1 m high and is semi-erect. The rhizomes resemble small nodules and produce large numbers of stolons. The leaves are rigid, erect, and short, with few hairs; the sheaths are slightly hairy. Stays green well into the dry season. Suitable for grazing, silage, fresh in feeding trough and hay, but drying is moderate.***

## Characteristics

| | |
|---|---|
| **Palatability** | good |
| **Digestibility** | good (50 – 60 %) |
| **Crude protein potential** | 7–10 % |
| **Tolerance to water logging** | moderate |
| **Tolerance to drought** | moderate |
| **Tolerance to shade** | moderate |
| **Water requirement** | 1000–3500 mm/year |
| **Planting density** | 8 kg/ha, down to 2 kg for seeds with high germination rates |
| **Planting depth** | 1–2 cm |
| **Germination** | 7–21 days |
| **Days to first cut** | ~ 90 days |
| **Time in rotation** | 25–45 days (wet season) 60–70 days (dry season) |
| **Plant height** | 60–100 cm |
| **Production potential** | 8–12 t Dry matter/ha/year |
| **Sol fertility requirements** | high |
| **Adaptability to soils with acid ph.** | high (3.9–7.5 pH) |

## Seedbed preparation

*Brachiaria* would require a well prepared seed bed. Due to small seeds, a fine seedbed would be preferable. As for most crops, seedbed preparation should be done well before the rains for ease of preparation and killing of weeds. If the piece of land is prone to obnoxious weeds, e.g. couch grass, herbicide spraying is advisable to systematically control these weeds. Plough to about 25 cm depth and harrow the land to obtain a fine soil tilts necessary for seeds that are small. Preferably avoid sloping and uneven land for lay the plots and minimize likely variations in performance.

## Establishment

Can be either planted in rows, 40–50 cm apart (8 kg /ha), or broadcasted sown at 10–12 kg/ha. For drilling through seed drills, be very careful not to bury the seed more than 2 cm in depth. Roller drills are preferred because they do not bury the seed too deeply, but instead press the seed just below the soil surface. For broadcast sowings, seed can be spread mechanically or hand sown. The seed must be covered after sowing by harrows. On small areas, tree branches or large brooms can be used to lightly cover the seeds with soil. Be careful not to bury the seeds more than 1–2 cm under the soil. Seeding can be started after 30 mm of rainfall.

## Fertilisation

After fertilizer application during planting (for the initial fertilization use a phosphorus dominated fertilizer to support root development – DAP), subsequent applications should be annually with nitrogenous fertilizer at a rate of 100 kg/ha of calcium ammonium nitrate (CAN). Application should be done after rains when the soils are wet enough to dissolve the fertilizer. Preferably, application should be after harvesting on wet soils to support the regrowth.

## Management

*Brachiaria* will take 80–90 days till the first cut. In rotation the following cuts can be done after 25–45 days while rainy season, respectively 60–70 while dry season.

Realized with the support of Federal Ministry for Economic Cooperation and Development (BMZ)

# *Brachiaria brizantha* cv. MG4

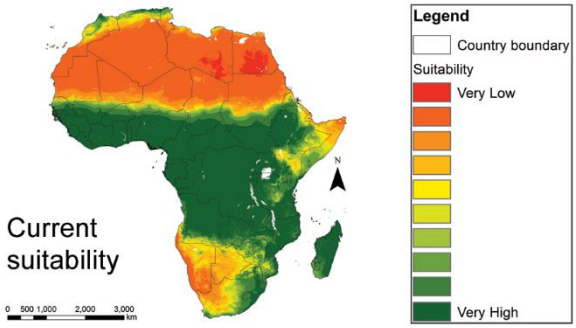



*Photo: Sementes Alvorada*

***Originally from Colombia. MG 4 stands 1.5 m high; has short, horizontal rhizomes which are yellow or purplish; intensely green stems that are vigorous, erect or semi- erect. The hairless leaves are linear-lanceolate and rounded at the base, usually 16 to 40 cm long and 10 to 20 mm wide. Leaf colour varies from light to deep green. Suitable for grazing, silage, fresh in feeding trough and hay, but drying is moderate. Quality of forage is good.***

## Characteristics

| | |
|---|---|
| **Palatability** | good |
| **Digestibility** | good (55– 70%) |
| **Crude protein potential** | 7–14 % |
| **Tolerance to water logging** | poor |
| **Tolerance to drought** | high |
| **Tolerance to shade** | good |
| **Water requirement** | 800–3500 mm/year |
| **Planting density** | 8 kg/ha, down to 4 kg for seeds with high germination rates |
| **Planting depth** | 1–2 cm |
| **Germination** | 7–21 days |
| **Days to first cut** | ~ 90 days |
| **Time in rotation** | 25–45 days (wet season) 60–70 days (dry season) |
| **Plant height** | 150 cm |
| **Production potential** | 10–18 t Dry matter/ha/year |
| **Sol fertility requirements** | medium |
| **Adaptability to soils with acid ph.** | high (4.0–8.0 pH) |

## Seedbed preparation

*Brachiaria* would require a well prepared seed bed. Due to the small seeds, a fine seedbed would be preferable. As for most crops, seedbed preparation should be done well before the rains for ease of preparation and killing of weeds. If the piece of land is prone to obnoxious weeds, e.g. couch grass, herbicide spraying is advisable to systematically control these weeds. Plough to about 25 cm depth and harrow the land to obtain a fine soil tilts necessary for seeds that are small. Preferably avoid sloping and uneven land for lay the plots and minimize likely variations in performance.

## Establishment

Can be either planted in rows, 40–50 cm apart (8 kg /ha), or broadcasted sown at 10–12 kg/ha. For drilling through seed drills, be very careful not to bury the seed more than 2 cm in depth. Roller drills are preferred because they do not bury the seed too deeply, but instead press the seed just below the soil surface. For broadcast sowings, seed can be spread mechanically or hand sown. The seed must be covered after sowing by harrows. On small areas, tree branches or large brooms can be used to lightly cover the seeds with soil. Be careful not to bury the seeds more than 1–2 cm under the soil. Seeding can be started after 30 mm of rainfall.

## Fertilisation

After fertilizer application during planting (for the initial fertilization use a phosphorus dominated fertilizer to support root development – DAP), subsequent applications should be annually with nitrogenous fertilizer at a rate of 100 kg/ha of calcium ammonium nitrate (CAN). Application should be done after rains when the soils are wet enough to dissolve the fertilizer. Preferably, application should be after harvesting on wet soils to support the regrowth.

## Management

*Brachiaria* will take 80–90 days till the first cut. In rotation the following cuts can be done after 25–45 days while rainy season, respectively 60–70 while dry season.

Realized with the support of Federal Ministry for Economic Cooperation and Development (BMZ)

# *Brachiaria brizantha* cv. Piatá

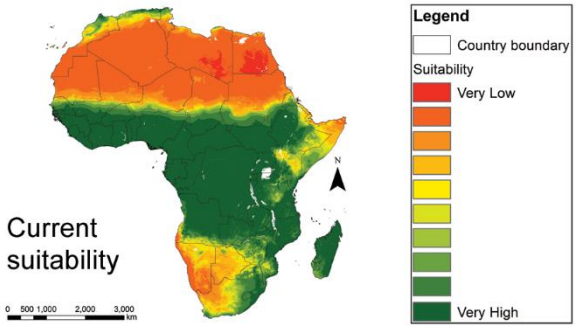



*Photo: Sementes Alvorada*

***Piatá is a leafy, vigorous, semi-decumbent perennial grass of medium height, growing to between 85–110 cm in height without inflorescences. It is a very leafy plant with about 57 % leafs in the produced biomass. The leaves are of a length of ~ 45 cm and a width of ~1.8 cm and show no hair. The stems are green and fine with a diameter of ~ 0.4 cm. Suitable for grazing, silage, fresh in feeding trough and hay, but drying is moderate.***

## Characteristics

| | |
|---|---|
| **Palatability** | good |
| **Digestibility** | good (55–70 %) |
| **Crude protein potential** | 7–14% (average 12%) |
| **Tolerance to water logging** | poor |
| **Tolerance to drought** | high |
| **Tolerance to shade** | good |
| **Water requirement** | 800–3500 mm/year |
| **Planting density** | 8–9 kg/ha, down to 4 kg for seeds with high germination rates |
| **Planting depth** | 1–2 cm |
| **Germination** | 7–21 days |
| **Days to first cut** | ~ 90 days |
| **Time in rotation** | 25–45 days (wet season) 60–70 days (dry season) |
| **Plant height** | 85–110 cm |
| **Production potential** | 8–15 t Dry matter/ha/year |
| **Sol fertility requirements** | medium |
| **Adaptability to soils with acid ph.** | medium (4.0 – 8.0 pH) |

## Seedbed preparation

*Brachiaria* would require a well prepared seed bed. Due to the small seeds, a fine seedbed would be preferable. As for most crops, seedbed preparation should be done well before the rains for ease of preparation and killing of weeds. If the piece of land is prone to obnoxious weeds, e.g. couch grass, herbicide spraying is advisable to systematically control these weeds. Plough to about 25 cm depth and harrow the land to obtain a fine soil tilts necessary for seeds that are small. Preferably avoid sloping and uneven land for lay the plots and minimize likely variations in performance.

## Establishment

Can be either planted in rows, 40–50 cm apart (8 kg /ha), or broadcasted sown at 10–12 kg/ha. For drilling through seed drills, be very careful not to bury the seed more than 2 cm in depth. Roller drills are preferred because they do not bury the seed too deeply, but instead press the seed just below the soil surface. For broadcast sowings, seed can be spread mechanically or hand sown. The seed must be covered after sowing by harrows. On small areas, tree branches or large brooms can be used to lightly cover the seeds with soil. Be careful not to bury the seeds more than 1–2 cm under the soil. Seeding can be started after 30 mm of rainfall.

## Fertilisation

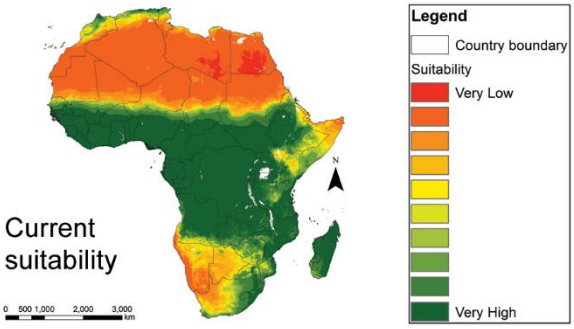
After fertilizer application during planting (for the initial fertilization use a phosphorus dominated fertilizer to support root development – DAP), subsequent applications should be annually with nitrogenous fertilizer at a rate of 100 kg/ha of calcium ammonium nitrate (CAN). Application should be done after rains when the soils are wet enough to dissolve the fertilizer. Preferably, application should be after harvest on wet soils to support the regrowth.

## Management

*Brachiaria* will take 80–90 days till the first cut. In rotation the following cuts can be done after 25–45 days while rainy season, respectively 60–70 while dry season.

Realized with the support of Federal Ministry for Economic Cooperation and Development (BMZ)

# *Brachiaria brizantha* cv. Xaraes (Toledo)




***Xaraes is forming well defined clumps reaching a height of 1.5 m. The deep green stems are strong, erect to semi erect with little branching. The hairless leaves are linear-lanceolate and vary in colour from light to deep green. The setting of inflorescences is very late. Suitable for grazing, silage, fresh in feeding trough and hay, but drying is moderate.***

## Characteristics

| | |
|---|---|
| **Palatability** | good |
| **Digestibility** | good (55–70 %) |
| **Crude protein potential** | 7–14% |
| **Tolerance to water logging** | poor–moderate |
| **Tolerance to drought** | medium |
| **Tolerance to shade** | good |
| **Water requirement** | 900–3500 mm/year |
| **Planting density** | 8 kg/ha, down to 4 kg for seeds with high germination rates |
| **Planting depth** | 2 cm |
| **Germination** | 7–21 days |
| **Days to first cut** | ~ 90 days |
| **Time in rotation** | 25–45 days (wet season) 60–70 days (dry season) |
| **Plant height** | 150 cm |
| **Production potential** | 10–18 t Dry matter/ha/year (CIAT) 20–30 t Dry matter/ha/year (SOESP) |
| **Sol fertility requirements** | medium |
| **Adaptability to soils with acid ph.** | medium (4.0 – 8.0 pH) |

## Seedbed preparation

*Brachiaria* would require a well prepared seed bed. Due to the small seeds, a fine seedbed would be preferable. As for most crops, seedbed preparation should be done well before the rains for ease of preparation and killing of weeds. If the piece of land is prone to obnoxious weeds, e.g. couch grass, herbicide spraying is advisable to systematically control these weeds. Plough to about 25 cm depth and harrow the land to obtain a fine soil tilts necessary for seeds that are small. Preferably avoid sloping and uneven land for lay the plots and minimize likely variations in performance.

## Establishment

Can be either planted in rows, 40–50 cm apart (8 kg /ha), or broadcasted sown at 10–12 kg/ha. For drilling through seed drills, be very careful not to bury the seed more than 2 cm in depth. Roller drills are preferred because they do not bury the seed too deeply, but instead press the seed just below the soil surface. For broadcast sowings, seed can be spread mechanically or hand sown. The seed must be covered after sowing by harrows. On small areas, tree branches or large brooms can be used to lightly cover the seeds with soil. Be careful not to bury the seeds more than 1–2 cm under the soil. Seeding can be started after 30 mm of rainfall.

## Fertilisation

After fertilizer application during planting (for the initial fertilization use a phosphorus dominated fertilizer to support root development – DAP), subsequent applications should be annually with nitrogenous fertilizer at a rate of 100 kg/ha of calcium ammonium nitrate (CAN). Application should be done after rains when the soils are wet enough to dissolve the fertilizer. Preferably, application should be after harvesting on wet soils to support the regrowth.

## Management

*Brachiaria* will take 80–90 days till the first cut. In rotation the following cuts can be done after 25–45 days while rainy season, respectively 60–70 while dry season.

Realized with the support of Federal Ministry for Economic Cooperation and Development (BMZ)