

Fodder trees and shrubs for livestock feed, income generation and environmental sustainability

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Livestock (goats, pigs, cattle, sheep and rabbits) are key components of farming systems in Uganda and are increasingly viewed as important pathways for rural households to escape poverty. Low quality and quantity of feeds are a major constraint limiting livestock productivity among smallholder farmers. This article reviews the role of fodder trees and shrubs to improve smallholders' livestock productivity, incomes and livelihoods.

Fodder (browse) is an agricultural term for animal feed, and fodder trees and shrubs are those plants (shoots or sprouts, especially tender twigs and stems of woody plants with their leaves, flowers, fruits or pods) that are raised, used and managed to feed livestock. Fodder plants provide the nutritional needs of animals. Examples of fodder trees are *Gliricidia sepium* (Gliricidia), *Leucaena leucocephala* (Leucaena), *Sesbania sesban* (Sesbania) and *Calliandra calothyrsus* (Calliandra). Fodder shrubs include *Tithonia diversifolia* (Mexican Sunflower) and *Cajanus cajana* (Pigeon peas)



***Calliandra calothyrsus* (Calliandra)**



***Gliricidia sepium* (Gliricidia)**



***Tithonia diversifolia* (Mexican sunflower)**



***Cajanus cajana* (Pigeon peas)**

Role of fodder trees and shrubs in a farming system

(a) High quality fodder supplement for livestock

Leguminous fodder trees and shrubs improve milk yield of dairy cows. Most of the evidence on milk yields involves calliandra and Mexican sunflower. Fodder trees have higher biomass yields, better resistance to mismanagement and a capacity to retain high quality foliage under stress conditions compared to herbaceous pasture legumes. Leaves of fodder trees and shrubs can be harvested, dried, milled and incorporated into feed rations such as dairy meal, nutrient feed blocks and dairy and calf pellets for home use or for sale. Fodder tree banks do not provide 100 percent of feed requirements but supplement available low-quality pasture and crop residues with high quality protein. Dairy cattle can feed with about 6 kg of fresh leaves of calliandra per day. To harvest 6 kgs fresh leaves of calliandra per day, you need to plant about 500 calliandra trees at a spacing of 0.5 metres, making 250 metres of hedge. This seems like a lot but a farm of 1 hectare, has over 400 metres of external boundary, plus additional sites (along internal boundaries, along contours, around the homesteads) where calliandra can be planted. One kilogram of dried calliandra (24 percent crude protein and digestibility of 60 percent when fed fresh) has about the same amount of digestible protein as 1 kg of dairy meal (16 percent crude protein and 80 percent digestibility). Two kilograms of dried calliandra provide an effective protein supplement to the basal feed of Napier grass and crop residues, according to on-farm feeding trials conducted in Masaka district by the National Livestock Resources Research Institute (NaLIRRI).

During the dry season, the natural pastures and crop residues available for dairy cattle after crop harvest are usually fibrous and lack most essential nutrients including proteins, energy, minerals and vitamins which are required for increased rumen microbial fermentation and improved performance of the host animal. Inadequate nutrition in dairy animals has often been associated with heavy economic losses to the farmers because of animal weight and condition losses, reduced milk yield and reproductive capacity and increased mortality rates. In order to improve the productive and reproductive capacity of smallholder ruminant animals, there is a need to look at ways of extending the availability and quality of feedstuffs produced on smallholder farms. Some of the benefits of supplementing fodder tree foliage to dairy cows include:

- (a) The most important aspect of fodder trees as a source of feed for dairy cows is the high protein content which ranges from 14 to 34 percent.
- (b) The protein content in fodder trees and shrubs consist of both soluble and insoluble components and as such is used both as an important source of nitrogen for increased rumen microbial activity and by-pass protein for supplying amino acids to the lower gut of the host animal.
- (c) Fodder legumes are an important source of minerals such as sulphur, calcium, copper and iron even though they have been shown to be a poor source of manganese, zinc and phosphorous.
- (d) The intake of dry matter is often increased by the amount of green fodder given to the animal. The increase in the intake of materials when animals are supplemented with fodder legumes may be due to increased microbial fermentation in the rumen and subsequent higher rate of passage of digesta through the gastro intestinal tract.

(b) Soil fertility improvement

Fodder trees and shrubs belong to the leguminous species. They have nodules that “fix” nitrogen from the air. This fixation process helps in improving soil fertility because nitrogen is one of the most important nutrients for plant growth. Animals fed with fodder trees such as calliandra produce high quality manure.

(c) Stabilizing soil and water conservation structures

Fodder trees and shrubs have deep and root system. When planted along soil conservation structures, they play a significant role in holding the soil together. They perform well in soil conservation when planted adjacent to lines of Napier grass terraces. The trees need to be planted at a close spacing of 0.5 metre. They should also be 0.5 metres above the Napier grass line. Fodder trees serve as hedgerows, contour strips, bund stabilizers

(d) Seed production and bee forage

It is advisable that a farmer preserves some fodder trees for seed/planting material production so that a farmer does not rely on external sources for future planting. Calliandra trees provide excellent bee forage, so a farmer has an additional benefit of honey production. Leave one tree uncut every 20 metres (about 20 steps) and make sure the total number left is more than 30. This improves the chances of cross-pollination and ensures that the seeds produced are of high genetic quality.

(e) Fuelwood

If left to grow uncut, fodder trees produce quality firewood. The wood burns better and has less smoke if left to dry well before use.

(f) Stakes for climbing beans and tomatoes

Stakes produced by fodder trees such as calliandra are good support for plants such as climbing beans, tomatoes and forage legumes.

(g) Source of income

The demand for seed/planting materials of fodder trees and shrub among livestock farmers is very high. Unemployed youth and women can produce seed, seedlings or/and cuttings for sale to livestock farmers. Currently, one kilogramme of calliandra seed costs over shs 40,000 while a-100 kg sac of gliricidia cuttings costs about shs 25,000.

Leaves and young stems of fodder tree and shrubs can be harvested, dried, milled and sold to feed producers. The leaf hay is currently a major component of high-quality dairy rations such as dairy meal, multi-nutrient feed blocks and dairy pellets. Members of Gulu Community Dairy Farmers’ Cooperative Society Limited in Gulu district plant Mexican sunflower, a shrub that is found along roadsides and use the dry leaves and young stems to make dairy pellets for sale to dairy farmers within and outside Gulu districts.



Dairy pellets produced by dairy farmers in Gulu district

Characteristics of ideal fodder tree and shrub species

The desirable agronomic characteristics of fodder trees are:

1. ease of establishment,
2. good competitive ability,
3. high productivity and persistence under repeated cutting or grazing,
4. ability to adapt to climatic edaphic conditions,
5. require no fertilizer (low input system),
6. resistant to local pests and diseases,
7. ability to produce seed or be reliable for vegetative propagation, and
8. have good nutritive value and reasonable palatability to animals

Establishment, management and utilization of fodder trees and shrubs

Climate and soils

Fodder trees and shrubs will grow in areas with rainfall of 700 mm per year and above. Due to their deep rooting habit, fodder trees and shrubs can withstand drought. They grow in varying soil types ranging from volcanic loamy to acidic soils, hence their wide distribution in Uganda. Calliandra and Gliricidia do not grow well in waterlogged soils, as sesbania.

Site preparation

Good site preparation is necessary to establish fodder banks. The goal is a weed free seedbed, in which plant growth and survival will be maximized. Fodder tree bank establishment must coincide with the rainy season to ensure high plant survival.

Propagation

Propagation can be done either by using seeds, seedlings or cuttings. Fodder tree seed and seedlings are available at the National Forestry Authority offices, Namanve, Kampala-Jinja road and at the National Forestry Resources Research Institute located in Mukono district. Fodder bank establishment is also possible with seedlings and cuttings. Species that can be established by cuttings include *Gliricidia* and Mexican sunflower.

Sowing fodder tree seed

Direct seeding is normally recommended for fodder bank establishment. Fodder tree seeds must be soaked in water or scarified to assure good germination.

1. A seedbed of 1 by 3 metres produces about 400 seedlings and requires 40 gms of seed. One and half kgs of seeds is sufficient for planting a nursery bed 40 metres long. This bed will produce about 5300 fodder trees, enough to feed 10 cows. This means that 100 gms of seeds would need a seedbed of about 7.5 metres that can produce about 1000 seedlings adequate to feed 2 cows.
2. To ensure good germination, you need to soak the seeds in cold water for 2 days.
3. Make a furrow about 2 cm deep in your bed for accurate sowing. Place the seeds in the furrow and cover them lightly with soil. Space the furrows 10 cm apart, and leave 6 cm between seeds within the furrow. Avoid putting the seeds too deep into the soil; this would make them rot.
4. Water the bed thoroughly immediately after sowing. You can use a watering can, a perforated tin or leafy branches. If termites are not a problem in your area, cover the seedbed with dry grass until the seeds germinate.
5. If you can afford plastic tubing materials, remove the seedlings after they produce two leaves and plant them in tubes filled with soil mixed with manure at the same rate as that for the raised beds. Using the tubes is an extra cost, but it improves the survival rate of the seedlings, especially if there is shortage of water.



Calliandra seedlings ready to be transplanted

6. Use your hand to estimate distance if you do not have measuring equipment. For example, the width of the palm is about 10 cm and the length of the first digit of the pointing finger is about 2.5 cm.

Applying Rhizobium inoculant

1. As with common beans, fodder trees such as calliandra have the ability to join with tiny organisms in the soil, known as *Rhizobium*, to form small, round balls known as root nodules. These nodules, which are usually less than 1 cm in diameter, trap and take nitrogen from the air and feed it to the plants. This process is called “nitrogen fixation”. By trapping nitrogen from the air, the root nodules not only help the plants to grow but also leave the soil more fertile than before.
2. In most places, the *Rhizobium* population to the soil is not enough to form adequate amounts of root nodules for nitrogen fixation. It is therefore necessary to get *Rhizobium* from other sources, such as the extension services or the soil beneath mature fodder trees. The *Rhizobium* inoculant has high populations of microorganisms that enhance root nodulation and hence nitrogen fixation.
3. Inoculant obtained from Makerere University of the National Agricultural Research Laboratories at Kawanda can be applied to either seeds or young seedlings. For seedlings, mix the inoculant with water in a bucket and stir well using a stick. A packet of 200 gms of inoculant can make a solution of 60 litres, which is enough for 40 metres of nursery bed in which 500 gms of seed has been sown. Water the seedlings thoroughly before applying the inoculant, to ensure better spread and distribution of the inoculum in the soil. Apply the *Rhizobium* using leafy branches, repeatedly dipping them into the inoculum solution and shaking it off on the seedlings.
4. If the inoculant is to be applied to seeds, mix it with water to make a solution. Mix the pre-soaked seeds with the solution and sow immediately avoiding excessive exposure to heat and light.
5. If the inoculant is obtained from the soil beneath mature fodder trees, scoop the topsoil and spread it on the nursery bed before sowing seeds. The *Rhizobium* will be incorporated into the soil and assist the plant to grow.

Nursery care and management

The following management practices are recommended for fodder tree seedlings to enhance their survival:

1. Carefully observe the moisture level in the nursery bed and water whenever it becomes dry. It may be necessary to water the seedlings twice a day (in the morning and evening) especially within the first 2 months after sowing the seeds.
2. Make a shade structure 1 metre in height and cover lightly with grass, papyrus mat or tree leaves ensuring that some light passes through.



Calliandra nursery bed

3. Remove all types of weeds.
4. Pests like grasshoppers, crickets and cutworms can cause heavy losses of seedlings if left unchecked. A good and cheap remedy against cutworms is fresh wood ash, which should be sprinkled around the seedlings. Some farmers apply mixtures made from plants like tobacco and garlic to repel insect pests. .

Planting out

1. Fodder tree seedlings are ready for transplanting 3 to 4 months after sowing. Depending on the weather, 2 weeks before planting time you should reduce watering to once every 2 to 3 days. By this time, you should have completely removed the shading material covering the nursery bed to prepare the seedlings to withstand the field conditions when they are transplanted.
2. Prepare the planting holes in advance on an appropriate site before removing the seedlings from the nursery. If manure is available, apply a-1kg tin of composted manure to every hole and mix well with the soil.
3. Remove the seedlings carefully from the nursery bed after watering the bed thoroughly. The best method involves using a sharp panga to first cut between the rows, then between the seedlings to form squares, and lastly under the seedlings so that you can lift the seedling with a cube of soil attached to the roots. This improves survival in the field.
4. Place a number of seedlings in a container such as a bucket or basin for safe and convenient transportation to the field. Cover the seedlings with a moist cloth or paper and take them to the planting site immediately. Prepare only as many seedlings as you can plant in one hour.

Introduction of fodder trees and shrubs in farming systems

The competitive land use between crops and livestock exerts considerable pressure against utilization of arable land for planting fodder crops and pastures. In this situation, a number of approaches have been suggested in order to incorporate fodder shrubs and trees without competing with crops. Four ways in which fodder shrubs and trees can be incorporated are:

1. Planting a living fence around the household

Fodder shrubs such as *Leucaena leucocephala* (Leucaena), *Gliricidia sepium* (Gliricidia) and *Sesbania grandiflora* (Sesbania) can be grown as living fences which provide not only human food and fuelwood but also animal feed. The fence can be established by direct seeding or transplanted seedlings at close spacing and be ready for use in 6–8 months. *Gliricidia* is easily established by sticking the stem or branch cuttings into the ground.

2. Vegetation on uncropped lands

In many of even the most intensively cropped areas of Uganda there are pockets of land which cannot be used for cropping. These may be in the form of farm boundaries, paddy bunds or forest margins which could be used to grow some shrubs and trees. These areas could be planted with fodder shrubs and trees to augment protein needs of livestock and integrated with plantation agriculture.

3. Hedgerows in alley cropping

Shrubs and fodder trees are grown as hedgerows in cropped land. These serve as windbreaks or heat breaks and provide green manure fertilizer for the crops. During the productive period, the cut material from the hedgerow species often provides fodder in excess of the amount needed from green manure for animals. Shade trees such as *Gliricidia*, used in cocoa plantations, can be treated the same way when they are routinely pruned to prevent overshadowing.

4. Component species in inter-cropping

In this system, shrubs or fodder trees are grown in alternate rows or rows adjacent to food crops. Trees are pruned once or twice for fodder or to reduce competition and shading during the growing period of the crops. Species used in this system are limited to fast growing ones and those tolerant to frequent cuttings. Examples of these include small shrub legumes like *Stylosanthes scabra*, *Stylosanthes viscosa*, *Cajanus cajan* and *Desmanthus virgatus*.

Establishment

A wide plant spacing, 50 x 50 cm or 60 cm x 60 cm, is usually recommended. Sowing depth of 1-2 times the width of fodder tree seed is recommended. In heavy soils, or when seed is small, sowing depth should be shallow. In dry environments sowing

depth should be deep. For most seed types, successful sowing methods vary from place to place. Use those methods practiced locally for a similar type of seed. Application rates for fertilizers should be determined locally. Consult your extension staff for the fertilizer rates.