PREFACE

This manual will provide a very useful tool for staff involved in forage development, animal husbandry, and soil conservation in Ethiopia. I wish to express my thanks to all those involved in the preparation of the document, and in particular to FARM (Africa) for generously providing the services of the Editor, Mr. Jim Miley, to the forage development staff of the Animal and Fisheries Resources Development Main Department (AFRDMD) particularly Ato Alemayehu Mengistu and Mr. Alan Robertson, for the technical inputs, and to Agri-Service Ethiopia for their perseverance in printing.

In view of the rapid expansion of information on species and technologies described, it is anticipated that the manual will require periodic updating, and this will be undertaken by AFRDMD.

Gizaw Nigussie
Vice Minister
Animal and Fisheries Resources Development
Main Department
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SECTION 1

INTRODUCTION

1.1 BACKGROUND

Livestock play a major role in Ethiopian agriculture. Cattle, sheep and goats produce milk, meat and hides for the farm families of the Ethiopian highlands.

For the subsistence highland farmer, draught oxen are the most important animals on the farm.

Currently many livestock are undernourished. They produce little meat or milk for the farmer and his family. Draught oxen are often so poorly fed that they are unable to work the plough when they are most needed.

The provision of increased quantities of high quality forage is urgently needed to improve livestock performance.

The Ethiopian Ministry of Agriculture is encouraging individual farmers and cooperatives to pay more attention to growing high quality forage to feed their animals, instead of allowing the animals to continually overgraze pastures.

Forage Development is crucial to the success of other livestock activities. Without a reliable supply of good quality feed, other livestock projects cannot succeed.
1.2 WHOM IS THE MANUAL FOR?

This manual sets out the basic guidelines for forage development and management at Service Cooperative, Producer Cooperative and farm level. The manual is written for Development Agents in the MoA but is useful for all extension workers. The manual may also be used for training DAs and livestock extension workers.

Development Agents and Forage extension workers should use the manual for reference as part of their day to day field work. Other staff involved in livestock production and nutrition will also find the manual useful.

1.3 HOW TO USE THE MANUAL

This document is not a text book or novel - it is a MANUAL. Readers should use the table of contents to refer to the section they need at a particular time. The DA should take the manual to the field if necessary to help in advising groups of farmers.

The manual is divided clearly into sections. This first section gives details on the guidelines for setting up a forage development programme. The guidelines include recommendations on farmer and cooperative selection and the necessity for strong links with other livestock and conservation projects.
In section 2 seven main strategies for forage development are outlined. Precise instructions on the management and use of pastures and forage crops are given in the third section.

Seed production is discussed in section 4. The fifth section gives the main points on forage establishment. Establishment by direct seeding, by seedlings and by splits and cuttings is discussed.

Finally, important information on the most suitable forage species is given in Annex 4 at the end of the manual. The annex provides a quick reference source on the main forage species as well as giving other important information. Sketches of the most important species are also included.

1.4 SETTING UP A FORAGE IMPROVEMENT PROGRAMME

Forage production in most areas of Ethiopia in the past has been based on uncontrolled grazing of native pastures. In such a system, livestock production is low, and overgrazing leads to severe erosion and soil fertility problems.

More emphasis needs to be placed on producing greater quantities of high quality forage. Forage improvement should be concentrated in the high potential areas where livestock numbers are high and where new high yielding species can be introduced.

The forage development strategies outlined in this manual are suitable for the more intensive livestock producing areas. In order for the strategies to succeed there need to be major changes in the management and use of forage.

The emphasis should be on Cut and Carry management rather than grazing.

An integrated approach to forage development is needed. Forage development should aim to:

- increase the quantity of forage.
- improve the quality of forage.
- assist in soil conservation.
- provide extra fuelwood through the use of tree legumes.
- increase the use of animal manure as fertiliser.
The following guidelines should be followed when setting up a forage development programme.

a) **Competition with Food and Cash Crops**

The best crop land is also the best land for forage production. Where the supply of land is limited care must be taken to avoid replacing food and cash crops with forage. The Development Agent must ensure that the forage development programme is integrated into the existing cropping system.

b) **Links with Other Projects**

The forage programme must be linked closely with other programmes. The final purpose of improved forage quantity and quality is to improve livestock performance. Strong links must, therefore, be maintained with the dairy, the fattening and the animal health programmes.

There must be regular contact too with soil and water conservation programmes. The erosion control benefits of the forage programme can be substantial.

The Development Agent is the person with responsibility for all agricultural activities at local level. It is up to him to ensure that the forage improvement programme is integrated with other livestock and agriculture programmes.
c) Farmer and Cooperative Selection

The forage programme involves the introduction of new ideas and concepts. It is essential to show good results quickly so that farmers will be convinced of the advantages of the programme. It is important to select the correct area and the correct farmers to work with.

Choose farmers who are known to accept new ideas quickly. In each area two or three key farmers should be chosen to act as motivators in improved forage production. These model farmers should be leaders within the community and popular among other farmers as well as being very good farmers.

It is important to produce a substantial quantity of high quality forage in the first year of the programme. This is the only sure way of gaining quick acceptance of the forage programme.

d) On - Farm Demonstrations

Many Development Agents and extension workers are inclined to set up their own demonstration plots and model farms for promoting new crops and ideas. This is often not the best approach for convincing farmers to change their production methods. It may show that the DA is capable of doing the work but not the farmers themselves.

It is much better to establish demonstration plots on actual farms. Most farmers are willing to cooperate, especially if free seed is supplied initially.

Other farmers will be more easily convinced of the advantages of a new forage species or cropping method if they see their neighbours already growing such crops successfully.

A well managed demonstration plot on an actual farm is better than weeks or months of talking or persuasion.
e) Scale of Operation

Small, well managed forage plots are better than big unmanageable units. In the first year or two the DA should concentrate on promoting the concept of forage development rather than producing huge quantities of the forage itself.

If the new concept or idea is successful on one farm or producer cooperative other farmers will quickly see the advantages and accept the new idea. However it is also important that the forage programme is sufficiently large to produce enough forage to demonstrate the benefits of improved nutrition.

In general, the DA should attempt to promote a large number of small forage plots in the Service Cooperative rather than a small number of large plots.

When choosing sites, access for regular supervision should be taken into account. If transport is not readily available the DA should try to keep the forage sites as close as possible so that he or she can visit often. This is particularly important for seed production (See section 4).

f) Flexibility

The forage development strategies outlined in section 2 are only general guidelines on forage production.

The various strategies should be regarded as a framework for forage development. At local level the DA could introduce changes to make the programme more suitable for his area. Advice is always available from awraja, zonal and head office staff.

As experience is gained with the forage programme the DA may find it necessary to change some aspects.

The forage project will only succeed if it maintains a maximum of flexibility to take into account local needs and conditions.
2.1 THE NEED FOR A NEW APPROACH

Overgrazing of native pastures is one of the most serious problems in Ethiopian livestock production. Pastures are grazed so intensively that plant vigour is reduced and the less productive and less palatable species begin to dominate. Soil erosion and reduced soil fertility result. The problem is particularly severe in sloping areas.

There are three important objectives behind forage development.

i) To increase the quantity of forage produced.
ii) To increase the quality of forage.
iii) To help prevent soil erosion.

The latter part of the dry season is the time when the problems of forage quantity and quality need special attention. Crop residues such as teff, barley and wheat straw, and maize or sorghum stalks are usually the major available feed at this time. The crop residues have a low feeding value. They are low in protein and low in digestibility.

At the end of the dry season many animals become undernourished and prone to illness. The problem is really severe in the case of draught oxen as they require good feeding at this time before the start of the ploughing season.

The new approach to forage production must concentrate on producing more protein-rich forage to supplement existing livestock feeds. The problem of soil erosion must also be addressed. The two crucial features of forage improvement are:

- It is CONSERVATION BASED.
- It promotes the growing of LEGUMES.
The major strategies for forage development involve some significant changes in the management and use of forage. These changes are summarised in the following rules for forage production. The Development Agent should always remember these rules when dealing with farmers.

1) Reduce uncontrolled grazing, especially on the steeper slopes.
2) Place a greater emphasis on soil conservation.
3) Cut and Carry the Forage where possible instead of grazing.
4) Use more legumes to improve forage quality and to increase soil fertility.
5) Use low cost forage production systems.
6) Integrate forage production with cropping systems. Do not displace crops with forage.

All of the forage improvement strategies are low cost. Fertiliser use is usually not recommended. The construction of expensive animal sheds or barbed wire fencing is also not recommended.

**FORAGE IMPROVEMENT STRATEGIES**

1) BACKYARD FORAGE PRODUCTION.
2) UNDERSOWING AND INTERPLANTING.
3) FORAGE STRIP ESTABLISHMENT.
4) OVERSOWING LEGUMES ON GRAZING AREAS.
5) PERMANENT GRASS/LEGUME PASTURE ESTABLISHMENT.
6) IMPROVED FORAGES IN STOCK EXCLUSION AREAS.
7) FODDER CROP PRODUCTION.
2.2 BACKYARD FORAGE PRODUCTION

Backyard forage production is the growing of forage in the house compound.

Forage plots or hedges in the backyard of the farm house are an easy and quick way of increasing forage production. Soil fertility in the backyard is usually high so forage plots can be very productive. The forage is produced near to where the animals are usually tethered. A small plot of 100sq.m. can provide 150kg dry matter per year. That's 1kg per day for 5 months which is enough to supplement the feed for one large animal.

Backyard forage plots can be of four types.

1) Hedges of tree legumes.
2) Mixed plots of perennial grasses and herbaceous legumes.
3) Productive legumes such as alfalfa.
4) Annual fodder crops such as fodder beet.

Farmers should be encouraged to establish hedges, or to grow forage plots of 50 to 100sq.m. The tree legumes may be most suitable for backyard forage in many cases because...

- they can be sown around the edges of the garden and therefore don't compete for space with other crops.
- they can be interplanted with existing backyard crops.
- they improve soil fertility.
- they provide shelter.
- they provide fuelwood.
When advising farmers to grow backyard forage, make sure to avoid replacing existing crops with forage. It is not advisable to grow extra feed for the farm animals if vegetables or protein crops for the farm family are reduced. However, the majority of households do have sufficient backyard space for some forage development.

Also, dual purpose crops such as pigeon peas can be grown as a forage crop with the peas harvested for use by the farm family.

Backyard forage is suitable for a variety of altitudes provided suitable species are suggested. Refer to Annex4 for more details on each species. The following species will be useful in many situations:

- **Hedges**: Leucaena, Sesbania, Gliricidia, Tree lucerne, Erythrina, Pigeon pea, Elephant grass.
- **Grass plots**: Elephant grass, Guinea grass, Phalaris.
- **Legume plots**: Alfalfa.
- **Dual Purpose**: Pigeon pea.
- **Root crop**: Fodder beet.

When and where to promote backyard forages:

- At all altitudes
- Where livestock numbers are high and grazing land is scarce.
- Where good control of livestock is possible.
- Where there is sufficient space in the backyard.
2.3 UNDERSOWING AND INTERPLANTING WITH LEGUMES

Undersowing involves the planting of forage legumes into another crop after the main crop is established.

The legumes are usually sown at the time of the final weeding of the main crop. However, they may be sown earlier where weeding is not thorough or where weeds are simply cut off rather than cultivated out.

The forage species are sown at low seeding rates in crops such as maize, sorghum, barley, wheat or plantation crops. In most areas maize and sorghum will be the main crops into which forage legumes are undersown.

In many areas undersowing is the best method of increasing forage production. It is readily accepted by the farmer because it does not disturb the existing cropping pattern on the farm.
Undersowing has a number of important purposes.
1) It improves the feeding value of the crop stubble.
2) It is a quick and easy method of establishing longer term pastures.
3) It improves soil fertility.
4) It provides extra food for the family if grain legumes are used.
5) It can also be used for forage seed production.

Sowing

The forage species are usually sown at the time of the final weeding of the main crop, and because initial growth is slow the forage will not compete with the main crop.

In areas where row planting is practiced legumes may be interplanted with the main crop.

Sowing rates should be low (See Annex4) but the seeding rate can be increased by two or three fold if the legume seed is to be harvested as a cash crop or for human consumption.

Growth

Growth of the legumes will be slow until the main crop is harvested. It is important, therefore, to choose deeprooting and drought tolerant species.

Grazing, cutting or cultivation of the undersown crop stubble should preferably be deferred until the legume seed has set. The seed may be collected for sale or allowed to shed for regeneration of the species in the following year.
Suitable Species

A range of legume species are suitable for undersowing. Grass species should be considered only where undersowing is used to establish a perennial pasture. Useful species should have most of the following characteristics:

1) The species should be deeprooting to allow the legumes to continue growing when the rains have stopped and the main crop has been harvested.
2) The species should retain their green leaves to increase the feeding value of the stubble.
3) The species must be easy to establish.
4) The species should seed heavily and early.
5) The species should have a proportion of hard seed to enable regeneration after final weeding in the following year.
6) If grain legume species are used they should be early maturing and drought tolerant.

For undersowing the following species are suitable (See Annex4 for more details on each species.)

Vetch, Lablab, Cowpeas, Greenleaf and Silverleaf Desmodium, Siratro, Axillaris, Verano stylo.
Other promising species include Cassia rotundifolia, Phaseolus acutifolius, Macrotyloma uniflorum and Trifolium spp. (including native Trifolium spp.)

Intercropping is a modification of undersowing which is useful in areas where row planting is common. Rows of forage legumes or dual purpose legumes are established, for example, after every second or third row of the cereal crop. The legume may be planted at the same time as, or after, the main crop.

Establishing pigeon pea with maize or sorghum is a good example of interplanting. It improves food security, stabilises crop production and provides extra forage.

When and where to promote undersowing:

- In intensive cropping areas where extra forage is needed.
- Where food legumes are not already undersown.
- When more high protein food is needed for humans.
- To establish long term pastures.
- To maintain or improve soil fertility.
2.4 FORAGE STRIP ESTABLISHMENT

Forage strips are narrow lines of forage established between arable crops.

Planting forage strips between arable crops is a useful method of forage production. The forage strips have a number of uses:

1) They provide forage for cut and carry.
2) They prevent soil erosion.
3) They provide wood for fuel and shelter belts if tree legumes are used.
4) They improve soil fertility.

Forage strips are an extremely useful method of forage improvement. However, it may be difficult for farmers to understand and appreciate the strategy in the initial stages. Very close supervision is required in the first couple of years.

There are four types of forage strips which may be recommended. The DA should decide which of the four is suitable for his particular area. This decision should be made in consultation with the farmer or cooperative representative.

1) Forage planted on bunds and terrace walls. These strips can be either in arable areas or in stock exclusion zones, but arable areas should be emphasised.

2) Forages planted on contour strips without bunds or terraces.

3) "Alley farming." This is where tree or shrub legumes are planted in
parallel rows in crop growing areas.

4) Forages planted as shelter belts around crop plots.

Tree legumes would form the basis of most forage strips where soil erosion control is required. A densely planted forage strip, without any gaps, is essential. A dense grass strip provides excellent erosion control, but grasses must always be mixed with tree legumes or herbaceous legumes. Creeping grasses must not be used in arable areas.

In soil erosion control, emphasis must shift from the construction of soil bunds to the use of vegetative contour planted strips which are inexpensive to establish but very effective in erosion control. The strips will result in the gradual formation of terraces over a long period.

A dense strip 1m wide, with a vertical interval of about 1m, is recommended.

For alley farming, tree legumes will be used. Herbaceous legumes may be sown within the tree legume strip to minimize weed invasion between the trees. Pigeon pea may be sown with the tree legumes, to provide initial fast growth while the slower growing tree legumes are becoming well established. Parallel strips are essential to enable easy cultivation of the crop area. A spacing of 4-8m between rows should be used, with the closer spacing in higher rainfall areas. 0.5m spacing between trees is suitable. Trees would generally be cut to about 1m height but low cutting height at the time of crop establishment will reduce competition.

Management of Forage Strips

Forage strips should be utilized by cut and carry, where possible, to maximize forage production and erosion control benefits. Livestock may be tethered close to the strips to minimize labour requirements and to avoid removal of nutrients from the site. If grasses are included in the strips, cutting should be sufficiently regular to avoid seeding of the grasses.
Recommended Species

The following species are useful for forage strips. (See Annex4 for more details.)

a) Bunds, terrace walls, contour strips.
   i) Erect grasses (such as Setaria, Guinea, Phalaris)
   ii) Herbaceous legumes: any persistent legumes plus vigorous ‘pioneer’ species such as Lablab and Vetch.
   ii) Tree legumes (such as Gliricidia, Leucaena, Sesbania, Tree lucerne) plus pigeon pea as a vigorous pioneer.

b) Alley farming.
   i) Tree legumes (such as Gliricidia, Leucaena, Sesbania, Tree lucerne, Calliandra)
   ii) Herbaceous legumes (optional)

c) Hedges/shelter belts.
   i) Tree legumes (such as Gliricidia, Leucaena, Tree lucerne, Erythrina) plus pigeon pea.
   ii) Elephant grass - mixed with climbing legumes and tree legumes.
When and where to promote forage strips:
- On slopes where soil erosion is a problem.
- On bunds and terraces.
- In arable areas where forage production is low at present.
- Where good control of livestock is possible.

2.5 OVERSOWING

Oversowing is the broadcasting of pasture seed on grazing areas without cultivation or fertiliser.

Oversowing is sometimes a useful method of increasing forage quality and production in existing pastures. It is the simplest and lowest cost forage development strategy and involves no change in grazing management. Legumes are more suitable for oversowing than grasses. Generally grasses have poor germination and are slow to establish on compacted soils.

It usually takes two or more years before the real benefits of oversowing are seen.

Oversowing has a number of advantages
1) It is very low cost.
2) It requires little labour.
3) It needs little or no management.
4) It improves forage production.
5) It maintains or increases soil fertility.

Sowing

The seed is broadcast very early in the season, before or at the beginning of the rainy season. This is vital to give the new species the best chance of survival. Sites with a loose soil surface should be chosen. Heavily compacted soils will result in poor germination and establishment. Seeding rates should be low, varying from 0.5 to 1.0 kg/ha depending on the species. Self seeding will result in the spread of the oversown species and increase in density.
There are three methods of oversowing.

1) Broadcasting seed over the entire grazing area at low seeding rates (eg 1 kg/ha).

2) Higher seeding rates (eg 2-3 kg/ha) can be used in narrow strips in the pasture or on patches in the grazing area where soil has been disturbed. The oversown species will then spread into the surrounding pasture.

3) Suitable species may also be sown from a vehicle along roadsides at a rate of 0.5kg to 1.0kg per km. As in strip sowing, the new species may then spread into the adjoining pasture. This is the most efficient form of oversowing.

Oversowing will be restricted mainly to the lower altitude areas.
Suitable species:

Suitable species must establish easily on poor seedbeds, tolerate heavy grazing, and be capable of setting seed and spreading even under heavy grazing. These include: Verano stylo, Seca stylo, Siratro, Axillaris, Calopo.

Other promising species include Cassia rotundifolia, Jointvetch, and Graham stylo. (See Annex 4 for details.)

When and where to promote oversowing:

- On poorer soils where a high cost system could not be justified.
- In areas with lighter and looser soils.
- Along roadsides.
- In pasture areas lacking a good legume content.

2.6 PERMANENT GRASS/LEGUME PASTURES

This involves establishing perennial mixed pastures on prepared seedbeds for utilisation by controlled grazing. The advantages of the system are:

1) It produces a high yielding, high quality forage.
2) The legumes improve or maintain soil fertility.
3) It allows a high stocking rate, and high levels of animal production with relatively low labour inputs.

This forage improvement strategy is, however, limited to high-producing enterprises with high cash returns. It has a high management requirement and is costly to establish. Seeding rates should be higher than with other strategies (eg. 6–10kg/ha). Fertiliser is often required for high production but nitrogen-based fertilisers are not needed because of the use of legumes. Some form of stock control such as fencing must be provided.

A well prepared seedbed is essential for permanent pasture establishment. Seedbed preparation for pastures is similar to that for cereal crops.
Permanent pastures may also be established by undersowing. Undersowing the pasture into a cereal crop is often more acceptable to the farmer and greatly reduces the cost of pasture establishment.

Mixed pasture productivity depends on good grazing management. These management skills can only be developed with time and by very close observations.

The general rules for pasture management are:

a) Usually the pasture should not be grazed lower than 10-15cm high for temperate pastures or 20—30cm high for tropical/subtropical pastures. Therefore adjust either stock numbers or area of pasture to suit. Do not allow pasture to become too mature.

b) Soil fertility in the mixed pasture area can be maintained largely by keeping stock on the pasture for a maximum number of hours per day. This avoids the excessive removal of nutrients in dung and urine.

c) Allow occasional seeding-down of various species in the pasture.

d) The grass and legume components should be kept approximately in balance. (Short term fluctuations are not a problem.)

e) Most weeds in a mixed pasture can be controlled by good grazing management.
Suitable Species

A very wide range of species may be combined in mixed pastures. Species adaptation is shown in Annex4. Possible mixtures include the following.

Low altitude: Rhodes, Green panic, Desmodium, Siratro, Stylo.
Medium altitude: Phalaris, Rhodes, Setaria, Desmodium, Trifolium.
High altitude: Phalaris, Cocksfoot, Tall fescue, Trifolium, Vetch (mainly as a pioneer species.)

When and where to promote permanent pastures:

- On good soils.
- In intensive livestock enterprises, particularly dairying.
- In areas with a longer growing season.
- Where management is good.

2.7 IMPROVED FORAGES IN STOCK EXCLUSION AREAS

This strategy is the introduction of improved forage species into areas from which livestock are permanently excluded.

Some areas are degraded and eroded so severely that there is no option but to exclude stock, thus enabling revegetation and prevention of further erosion. Stock exclusion areas are generally extremely degraded, with existing forage quantity and quality very low. Without improvement they are not very useful to local farmers. The development strategy is designed to prevent further soil erosion and provide forage for cut and carry management.
Herbaceous legumes are usually more suitable for these areas, although some grass species may be introduced after the soil fertility begins to improve. Tree legumes may also be suitable in some cases but they need to have a colonising ability (e.g., Tree lucerne).

This system depends on the strict exclusion of livestock from the area, with cut and carry management only. The introduction of improved species in stock exclusion areas is more suitable for the low to medium altitude areas.

Seeding rates should be low to medium (2 to 3kg/ha) and early sowing is essential. Sowing before the rains is preferable in some cases.

**Sowing**

Forage seeds should be sown in disturbed areas within the stock exclusion zone. Natural or man-made micro-catchments are ideal for forage species. There are usually plenty of microcatchments available in areas where soil and water conservation work has been carried out. Sow a 'fingerpinch' of seed per microcatchment before or at the beginning of the rains. In areas where there is no physical soil disturbance, select relatively loose surfaces for sowing. Always use low seeding rates.

**Suitable Species:**

Persistent, drought resistant legume species, with the ability to set seed and spread, are recommended for stock exclusion zones. Climbing or sprawling legumes are particularly well suited. The following species are useful: (See Annex 4 for more details on the species.)

Herbaceous legumes: Siratro, Axillaris, Calopo, Verano stylo, Seca stylo, Graham stylo, Greenleaf, and Silverleaf Desmodium (the latter two on better soils), Cassia rotundifolia.

Grasses: Buffel grass, Rhodes grass, Plicatulum.

Tree legumes: Sesbania, Tree lucerne (direct seeding).

**When and where to promote improvement of exclusion areas:**

- Immediately after the area has been designated for exclusion.
- Where the local community is willing to control livestock access.
- Mostly at low to medium altitudes.
- Where soils are good enough to allow at least moderate productivity.
- In areas where there has been some soil disturbance eg. microcatchments for tree planting.
- Near villages so that utilisation by cut and carry is possible.

It is important to realise that livestock exclusion programmes, if well designed, can greatly increase livestock production (mainly because grasses and legumes are much more productive under occasional cutting than under heavy grazing pressure.)

2.8 FODDER CROPS

This strategy involves the growing of high yielding, high quality short-term crops for intensive livestock feeding.

Crops such as Alfalfa, Oats, Vetch and Fodder beet can be grown over a wide range of altitudes.

Like permanent pasture establishment, fodder crops should be restricted to intensive livestock systems, especially dairying.

Fodder crops are useful because:
1) They provide a large quantity of high quality fodder in a short time.
2) They are acceptable to the farmer.
3) They are generally easy to grow, with husbandry requirements similar to other crops familiar to the farmer.
4) They are palatable.
5) They are already well proven in many areas.
6) They are often a convenient way of introducing farmers to the concept of improved livestock nutrition.

However, fodder crops are costly to produce, especially in terms of cultivation costs. Another problem is that the land is exposed to erosion for part of the year. Growing fodder crops requires good management and husbandry practices. Care should be taken not to displace food or cash crops with fodder crops.
Suitable species include Oats, Vetch, Alfalfa and Fodder beet.

When and where to promote fodder crops:
- On fertile soils.
- For intensive livestock enterprises, mainly dairying.
- Where extra land is available so that food production will not be reduced.
- In sites convenient for cut-and-carry utilization.
3.1 INTRODUCTION

Establishing new forage sources is useful only if the forage is managed and used efficiently. Newly sown forage species need time to establish so grazing and cutting management is especially important in the first year. Uncontrolled grazing has led to severe soil erosion problems in the past. Restricting grazing will, in most cases, lead to reduced livestock numbers which is usually unacceptable to farmers.

For this reason, cut and carry management is recommended wherever labour is available.

3.2 CUT AND CARRY

Cutting forage for hand feeding to livestock is the recommended method of using forage in most areas of Ethiopia. The cut and carry system allows the farmer to completely control the use of his forage.

Benefits of cut and carry

1) It increases livestock performance through higher forage production and higher rates of utilisation.
2) It avoids wastage of forage by animal faeces on pastures.
3) It reduces internal parasite problems, especially in wet areas.
4) It avoids destruction of the pasture by overgrazing.
5) It helps to control soil erosion.

The main problem with cut and carry is that it demands more labour than grazing. However, even if labour on the farm is scarce, it may be possible to use 'cut and carry' at times when other activities on the farm are limited. Cut and carry can be used for all types of forage species and for all strategies except oversowing of grazing areas.

Another problem with cut and carry is that soil fertility can rapidly decrease. No dung, urine or forage are left on the pasture as is the case with grazing. Therefore the DA should encourage farmers to tether and feed their animals as close as possible to where the forage is growing.

This has two advantages:
1) It reduces the labour requirement for carrying the forage.
2) It allows the animal's manure to be spread easily onto the forage or crop area. Spreading may not be necessary if the animal is tethered in a different position from time to time.

The provision of adequate drinking water is essential for good performance.
When to cut the Forage

Forage is at its best when it is young and green. It is more palatable and nutritious than older, drier forage.

The DA should advise farmers to cut and use their forage while it is still fresh and green.

Climbing legumes must not be cut too low. Low cutting may reduce the ability of the climbing legumes to regrow quickly. Most grasses can be cut low without seriously affecting their ability for regrowth.

Grasses decline in feeding value much more quickly than legumes so they should be cut frequently, eg. every 4 weeks.

Tree legumes should generally be cut to a height of about 1 metre. Cutting should be carried out every 6 to 8 weeks. This increases the proportion of leaves on the tree legumes and as a result the feeding value is increased. Longer cutting intervals may be used where there is a need for fuelwood.

The high quality leguminous forage would be used mainly to supplement readily available, lower-quality feed stuffs such as crop straws. The proportion of legume should generally be 20-30% of the ration, but even 10% will result in marked improvement in livestock production. The addition of low cost by-products such as nougcake (eg. at 10% of ration) will have an additional large benefit.
Excess leguminous forage may also be cut and used as a mulch in cropping areas. Mulching with leguminous forage is very useful in forage strips and in the undersowing and interplanting strategies. The leguminous forage has a high value as a mulch. It retains soil moisture and helps to maintain soil fertility.

Forage is not always needed for feeding when it is at its best. Forage conservation is, therefore, necessary, and advisable in many cases.

3.3 FORAGE CONSERVATION

Providing quality forage for animals in the dry season is one of the biggest problems in animal production in Ethiopia.

There are two methods of solving the problem of lack of good quality forage in the dry season.

i) The growing of forage, especially legumes, which provide high quality feed for a longer period than native grasses, is one solution. This is the main goal behind the various forage development strategies outlined earlier.

ii) Forage conservation is the other means of overcoming the shortage in the dry season.

Forage conservation helps to bridge the gap between the feed requirement of the livestock and the production of forage. If good quality forage is conserved, the gap between high quality (wet season) and low quality (dry season) may also be bridged.

Hay is the only conserved forage that is appropriate in small-scale farming in Ethiopia.

Forage conservation, however, may only be suitable in some situations. In less intensive systems it may be cheaper and more convenient to grow tree and herbaceous legumes that are drought tolerant. These legumes can then be used for browsing or for cut and carry management.

Forage conservation is well suited for intensive dairying and fattening operations.
What to conserve

The sward should ideally be a mixture of grasses and herbaceous-legumes. The legumes increase the digestibility and intake of the conserved forage.

Most grasses are good for hay production. The erect grasses are very convenient for cutting. When combined with legumes such as Vetch, Alfalfa, Siratro etc., they make excellent quality hay. Oats mixed with Vetch is already grown in many areas and is ideally suited for conservation.

It is important to be careful when cutting climbing legumes. If the climbing legumes are cut too early they may have difficulty in re-establishing in the swards. The climbing legumes should not be cut too low as this also may result in regeneration difficulties.

When to cut hay

For high quality forage, the sward should be cut just before flowering. This will produce reasonable yields of hay with
- high digestibility and
- high protein content

Cutting hay at this time will usually give lower yields than cutting after flowering so it may be difficult to convince farmers to cut hay at this stage. Traditionally many farmers wait until the end of the wet season before cutting hay. The clear message for hay cutting is:

Cut the hay just before the species flower. This means that cutting will often take place from 4 to 6 weeks after the pasture is closed.

Conservation guidelines

Hay production is a simple task but a lot of poor quality hay is produced through simple mistakes. The following rules should apply.
- Cut the hay before flowering of the grass species.
- Try to time cutting for a gap in the rains.
- Dry the hay as quickly as possible.
- Keep the hay mould-free by regular turning.
- Once dry, stack the hay using the ‘heap-up’ method.
- Ensure that the hay stacks are rainproof.
When conserving crop residues layers of legumes, if available, should be laid between the crop residues. This increases the feeding value of the crop residues and provides a balanced diet for the livestock.

Flat topped and broad haystacks are not weather proof. The hay will be damaged by rain.

3.4 GRAZING MANAGEMENT

Most forage development strategies are directed towards utilization by cut-and-carry. However, grazing management is important in some situations:

a) For native pastures where some control of livestock is possible.

b) For sown grass/legume pastures.

The objective of grazing management is to maximise animal production from the pasture over a very long period. Pasture stability is very important, but short term fluctuations in pasture composition are acceptable. Overgrazing results in reduced plant vigour, a shift from more palatable to less palatable species, and increased soil erosion.
Undergrazing may also have negative effects. Pastures become rank and unpalatable, and some less desirable species may begin to dominate. The final result is that animal production is reduced.

**Rules of grazing management**

Good grazing management requires good skills and very good control over livestock. The skills will develop through close observation of pasture species and animal production over a long period of grazing. The following general rules will apply in most situations:

1) Grazing management should try to maintain a long-term balance between the grass and legume components, but short-term fluctuations are acceptable.

2) Control most pasture weeds by grazing. Climbing legumes and vigorous grasses will be most effective in competing with weeds.

3) Adjust grazing to allow occasional seeding-down of various species in the pasture.

4) Keep grazing animals on the pasture for a maximum number of hours each day. This ensures that soil fertility is maintained by dung and urine. Secure night paddocks may allow selected stock to continue to graze through the night.

5) Generally, the pasture should not be grazed lower than 10-15cm high for temperate pastures or 20-30cm high for tropical/sub tropical pastures. Most climbing legumes are particularly susceptible to heavy grazing pressure. Adjust either stock numbers or area of pasture to achieve a balance.

6) Rotational grazing may have substantial benefits in terms of parasite control. Forage production is often higher in rotationally grazed temperate pastures, but results with tropical/sub-tropical pastures are quite variable. Rotational grazing must be very flexible to avoid animal stress on the smaller pasture areas.
7) Segregate the herd or flock. Allow the young animals to graze the pasture first. This allows them to get the best quality forage and assists in parasite control. Lactating females should also be given preference.

8) A mixed grazing system may have some advantages, because sheep have different grazing preferences from cattle. Post and wire fencing is not essential for grazing management. Living fences, or even lines of trees or stones separating paddocks, may be quite successful if reliable herdsman are used.
SECTION 4

FORAGE SEED PRODUCTION

4.1 INTRODUCTION

Imported forage seed is expensive and sometimes difficult to obtain on time. It is important that a major effort is made to make Ethiopia self-sufficient in forage seed.

The Ministry of Agriculture has introduced the seed contract system of forage seed production. The aim is to produce high quality seed locally at a lower price and in greater quantities than with centrally controlled seed production systems.

4.2 THE CONTRACT SEED SYSTEM

This system involves producing seed under contract with SCs, PCs, and individual farmers.

The main features of the contract seed system are as follows:

i) The producer is paid contract rates per quantity of clean seed produced.

ii) Standard prices will be paid throughout the project area.

iii) Prices will be revised annually if necessary.

Forage seed production should be regarded as a good cash crop. It does not compete to any great extent with food crops or other cash crops because overall production is likely to be very small relative to other crops.

The great majority of seed production will be under rainfed conditions. The seed contract is very attractive for most farmers and cooperatives and economic returns are better than for most cash crops.
The seed contract is a legally binding agreement between the Ministry of Agriculture and farmer or cooperative. Both the MOA and the producer must make certain commitments under the seed contract.

The Ministry of Agriculture must...
- provide seed for sowing (at least in the initial stages)
- provide close supervision and technical back-up for the seed plots.
- purchase the seed in cash at an agreed price at a specified time.

The farmer or cooperative agrees to...
- produce high quality seed under specified management conditions.
- grow the seed in an area of the farm specified by the MOA representative.
- control stock access to the seed site and provide good weed control.
- clean the seed after harvest and deliver at a specified time.

There are several 'systems' of seed production. The choice of system depends on...
- the species
- the labour supply
- the management level
- the level of supervision that is available
- the potential yield.

The most intensive seed production method is the specialised plot system.
4.3 SEED FROM SPECIALISED PLOTS

Certain species which have a high yield potential may be grown on specialised plots. These plots will require a lot of labour and also have a high management requirement. Specialised plots are very suitable for the rapid multiplication of new forage species. Species such as Siratro, which have a high labour requirement due to prolonged harvesting, should also be grown on specialised plots.

Species suitable for growing on specialised plots include:
Siratro
Axillaris
Glycine
Desmodium
Vetch
Verano stylo

For an individual farmer the maximum size of a seed plot should be about 0.2 to 0.4 hectares. Larger plots are difficult to manage and have a very high labour requirement.

Tree legume seeds may be harvested from specialised seed plots or from areas where the tree legumes are established primarily for forage.

Trellising

Trellising is the growing of climbing legumes on a support such as post and wire fences.

On specialised seed production plots where climbing legumes are grown trellising is recommended.
There are two major advantages with trellising.

1) It results in higher seed yields.
2) It makes harvesting easier and more efficient.

The increased yields with trellising will justify the extra cost involved. Harvested yields for trellised Siratro, for example, can be as high as 3000kg per hectare compared to only 500kg per hectare without trellising.

High cost trellising involves the use of post and wire fencing. Posts are erected 3m apart and 1.8m above ground level. Three or four rows of plain wire are attached to the posts. Strands of wire are also threaded vertically through the horizontal rows.

Low cost trellising is also possible. Abandoned chat growing sites are a useful form of natural trellising. Erect leguminous trees with the side branches cut are also useful. Rows should be 3m apart with 1m between the trees. Leucaena, Sesbania and Gliricidia trees are ideally suited for trellising.

4.4 SEED FROM STOCK EXCLUSION AREAS

Areas from which stock are excluded may be useful for seed collection. Yields may be low but the cash from the seed sales may be the only cash income that the farmer or PC will receive from that area.

Labour is the only real cost in collecting seed from stock exclusion areas.

Species suitable for this system include:
Seca stylo, Buffel grass, Siratro, Desmodium, Axillaris and Calopo.
Stock exclusion areas are generally not suitable for the seed collection of most grass species.
4.5 GRASS SEED PRODUCTION

The production of good quality grass seed requires close supervision especially at harvest time. Yields from grasses are lower than from legumes and losses during harvest are usually higher.

The collection of grass seed under the contract system should be restricted mainly to dairy cooperatives. The cooperative could be assisted in establishing an improved pasture, with the agreement that the area would occasionally be closed from grazing to enable seed collection to be carried out.

Most grass species may be collected in this way. Grass seed collection is, however, much more difficult than collecting legume seeds. Grass seed plots should be fairly large, e.g. 5 ha. per site. This makes close supervision at harvest much easier.

4.6 OTHER SOURCES OF SEED

Apart from these ‘systems’ of forage seed production, DAs should encourage farmers to produce seed in other situations. This should always be done in consultation with the seed production coordinator.

Undersown forage legumes, and strip planted forages may be useful for producing seed. The forage will still have a high feeding value after the seed has been harvested.

It is not always necessary to have a formal contract in these situations. Supervision and advice must always be provided by the DA with support from the MOA seed coordinator.

4.7 SITE SELECTION

The choice of site is vital for seed production. The DA should choose sites that are accessible and close together so that he can supervise the seed production more closely. Sites with a high yield potential should be chosen.

Other factors for selecting seed production sites are:
- there must be easy access.
- closely related species must not be grown within the same Service Cooperative.
- the area must be free of serious weeds.
- the species must be well suited to that area.
4.8 SEED STORAGE

To maintain the quality and viability of the seed it is necessary to store the forage seed safely. For good storage low moisture and temperature conditions are necessary. Forage seed can be stored successfully at 15°C to 18°C, and 8% to 10% moisture.

As a general rule the followings figures can be given:
- each 5 degree C reduction in temperature doubles the storage life.
- each 1-2% reduction in moisture doubles the storage life.

The seed should be stored in a cool, well ventilated and dry shed.

Storing seed in bulk on a bare floor has a number of disadvantages.
- the seed may absorb moisture from the floor or the air.
- rodent damage is likely.
- insect damage may also be a problem.

Rodents and insects can be controlled only when storage areas are kept extremely clean and tidy.

A low cost method of storing legume seed is to pack the seed in sacks and store on a rack. Sealed storage in drums or bins is advisable for longer term storage of grass seed. This will greatly reduce the risk of insect and rodent damage.

The seed should be properly dried and cleaned before being placed in the sacks or bins. Each sack or bin must be clearly labelled.
The label should include the following information:
- species name
- cultivar name
- date and place of harvest
- weight

4.9 SEED DRYING

In most areas grass and legume seed will not be dry enough for storage at the time of harvest. To maintain good seed viability, storage must take place at low moistures and low temperatures.

There are three basic rules for seed drying.
- If moisture is high, start drying at lower temperatures.
- Dry the seed slowly (not less than 3 days) and evenly.
- Avoid sun-drying until the moisture content is low (below 10%).

The method of drying most grass seed is different from that of drying legumes. With most grasses the moisture should be retained for several days before drying. This process, known as sweating, helps mature the grass seed and increases viability. The procedure for drying legume seed is the same as for grasses but 'sweating' is not necessary.

For drying most grasses the following step-by-step guide should be followed:

1) Stack the bundles of seed heads on the floor of a well ventilated shed at a depth of not more than 50cm.
2) Leave the bundles there for 2 to 3 days to allow 'sweating', but turn at least once per day to keep the temperature down.
3) After three days shake the seed from the seed heads.
4) Dry the seed by spreading a thin layer on a shaded place.

5) Turn the seed frequently.
6) When the seed is almost dry (about 9% or 10% moisture) the drying process may be completed by sun-drying if necessary.
SECTION 5

FORAGE ESTABLISHMENT

5.1 INTRODUCTION

There are three methods of establishing or propagating forages.
- Direct seeding
- Seedlings
- Cuttings and splits

The method of propagation depends on the species, the seed availability and the environmental conditions.

A general guideline on the most appropriate method of establishment for each type of forage is given in Table 5.1.

Table 5.1

<table>
<thead>
<tr>
<th>Type of Forage</th>
<th>Method of Establishment</th>
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</thead>
<tbody>
<tr>
<td>Tree legumes</td>
<td>Seedlings</td>
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<tr>
<td></td>
<td>Cuttings</td>
</tr>
<tr>
<td></td>
<td>Direct Seeding only</td>
</tr>
<tr>
<td>Herbaceous legumes</td>
<td>Direct seeding only</td>
</tr>
<tr>
<td>Grasses</td>
<td>Direct seeding</td>
</tr>
<tr>
<td></td>
<td>Cuttings</td>
</tr>
<tr>
<td></td>
<td>Splits</td>
</tr>
</tbody>
</table>

5.2 DIRECT SEEDING

Direct seeding is used for all herbaceous legumes, for most grasses and in certain cases for tree legumes. There are three methods of direct seeding.
- broadcasting
- row seeding
- spot seeding

Early sowing is often the key to successful forage establishment. For almost all species seeding should take place at the beginning of the rains, or just prior to the rains. Dry planting may be appropriate for hardier species such as:
Siratro, Seca stylo and Verano stylo. It is also appropriate for establishing various forage strategies, particularly oversowing and improvement of exclusion areas, and sometimes for forage strips and permanent pastures. Dry planting may be especially useful in cases where other cropping activity will demand a lot of labour at the onset of rains. For undersowing, the seed is generally broadcast at the time of the final weeding of the main crop.

Where low seeding rates are recommended, eg. for oversowing, or sowing small seeded species such as Greenleaf Desmodium, it may be necessary to mix the seed with sand to make broadcasting easier. In the case of tree legumes the seed is usually spot planted with 2 or 3 seeds per hole.

Before sowing seed it is useful to determine its viability by carrying out a germination test. Certain species also require seed treatment and some legume seed must be inoculated.

1) Germination test

It is advisable to check the viability of forage seed before planting. This can be done by a simple germination test.

A shallow dish or tray covered with moist blotting paper is needed to carry out a germination test. The following is the correct procedure.

i) Place the blotting paper in the germination tray and moisten. Do not wet the paper.
ii) Place 100 seeds in the tray, scattering them evenly.
iii) Leave the tray to stand at room temperature.
iv) Keep the blotting paper moist all of the time.
v) Check the seeds once per day and count the seeds that have germinated.
vi) With most species germination will be complete within one week but the germination period may be longer in some cases.
vii) When the test is completed, the number of seeds that have germinated is expressed as the germination percentage.
2) Seed Treatment

Seed treatment is necessary for many legume species in order to increase the germination rate and break dormancy in some seeds. The following seed treatment method is suitable for most legume species with a high percentage of hard seed.

i) Boil a container of water.
ii) Remove the water from the heat source, and immediately immerse the seed for treatment.
iii) Soak the seed in the warm water for at least five to ten minutes. The seed may be placed in a porous bag for ease of handling. The time for soaking varies with different species. This treatment breaks seed dormancy and improves germination. Some seeds such as Tree lucerne and Leucaena should be boiled for 5 to 10 minutes.
iv) Sow a mixture of treated (80%) and untreated (20%) seed. This ensures a better survival rate if there is a long dry period after initial germination.

3) Seed Inoculation

Some legumes need to be inoculated before sowing. Inoculation of these with a specific strain of rhizobium results in more efficient nitrogen fixing and produces better growth rates.

Inoculation simply means sticking a viable culture of the inoculant to each seed just before sowing.

The materials needed for inoculation are:
i) the seed
ii) the inoculant
iii) a sticking agent
The best sticking agents are a 40% gum arabic solution in water or a 4% methyl cellulose solution in water. A sticking agent may also be made using a concentrated sugar solution in water.

The inoculant and the inoculated seed must be kept cool at all times. The following is the procedure for inoculation:

i) Mix the sticking agent solution with the required amount of inoculant. The mixing may be done in a plastic bag. Up to twice as much inoculant as recommended on the packet can be used.

ii) Continue mixing until an even 'slurry' is formed.

iii) Mix the 'slurry' with the required quantity of seed. This mixing can also be done in a plastic bag. Add more sticking agent if necessary.

iv) Mixing should continue until every seed has a fine sticky coating of the slurry.

v) Spread the seed to dry in a cool shady area.

Once mixed the inoculated seed should be used as soon as possible. The following rules apply to inoculated seed.

i) Sow the inoculated seed as quickly as possible.

ii) If not sown immediately store the seed in a cool place.
iii) Do not store for more than 3 days. After that the inoculation must be repeated.
iv) Do not expose the inoculant, or the inoculated seed, to direct sunlight.
v) Do not mix the inoculated seed with fertiliser or chemicals.

If inoculant is not available the seed may be mixed with soil which has been collected from around the roots of well nodulated legume plants of the same species.

Species such as Leucaena and Lotononis should always be inoculated. Many other species, including Tree lucerne and Desmodium spp. will benefit from inoculation on many sites.

5.3 SEEDLINGS

Seedlings are produced in a nursery. The plants are grown in specialised intensive plots and are planted out when they are of a suitable size or when moisture conditions are suitable. Planting out should take place at the start of the wet season. The planting out site must be well prepared and transport should be well organised in advance.

Seedlings may be either potted or bare-root. Either type of seedling may also be bare-stem. Moisture losses during transport and immediately after planting are greatly reduced with barestem seedlings. With this technique all of the leaves are removed from the stems immediately before uplifting. The seedlings are then packed tightly in bundles of 100 or 200 and covered with wet sacks for transporting to the planting out site. One man can easily carry 200 bare-root bare-stem seedlings.

Potted seedlings generally have a better survival rate than bare-root seedlings but the survival rate of bare-root seedlings is greatly increased by removing all of the leaves before uplifting.

Tree legume species are the only forage species which will be produced from seedlings. The advantages and disadvantages of each type of seedling are shown in Table 5.2.
### Table 5.2: Comparison of Potted and Bare-Root Seedlings

<table>
<thead>
<tr>
<th>Type of Seedling</th>
<th>Advantages</th>
<th>Disadvantages</th>
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</thead>
<tbody>
<tr>
<td>Potted</td>
<td>better survival rates</td>
<td>more complicated</td>
</tr>
<tr>
<td></td>
<td>easier to grow</td>
<td>more labour intensive</td>
</tr>
<tr>
<td></td>
<td>easier to transport</td>
<td>more difficult to transport</td>
</tr>
<tr>
<td></td>
<td>much lower cost</td>
<td>much more expensive</td>
</tr>
<tr>
<td></td>
<td>need less labour</td>
<td>need more care when uplifting</td>
</tr>
<tr>
<td></td>
<td>larger seedlings possible</td>
<td>more difficult to store when</td>
</tr>
<tr>
<td></td>
<td></td>
<td>uplifted</td>
</tr>
<tr>
<td>Bare-Root</td>
<td></td>
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</tbody>
</table>
Tree legumes grown from seedlings have the major advantage that the survival rate is increased (if planting out occurs early in the season.)

This is important where seed is scarce or seed prices are high. Another advantage is that the plants grown from seedlings will be well established very early in the season. This is important because it encourages more farmer interest.

Also, inoculation is generally more convenient in nurseries compared with a large number of field sites. However, seedling production is:
- more complicated
- more labour intensive
- and more expensive
than direct seeding or propagation with cuttings.

Forage seedling nurseries do not need to be large. Individual farmers or cooperatives can manage small seedling nurseries, particularly for bare-root seedlings.

Larger seedling nurseries must be located near an all-weather road. The nursery should also be as close as possible to the planting out site to reduce transport costs or to allow farmers to transport the seedlings themselves by donkey or mule.

The nursery must be situated close to a reliable water supply. The nursery should be protected from strong winds by shelter belts.
Full details on the management of nurseries are given in the manual 'Establishment and Management of Nurseries', produced by the MOA.

Important information on nursery size and labour supply requirements are given in Annex 3 of this manual.

5.4 CUTTINGS

Cuttings are a suitable method for propagating some forage species. Cuttings are suitable mainly for tree legumes, particularly Gliricidia, (but also for some grasses.) Cuttings are cheaper and avoid the problems and cost of purchasing seed or producing seedlings in a nursery.

1) Tree legume cuttings

Cuttings from tree legumes should be taken from mature branches. Cut woody sections 30 to 50 cm long about the thickness of your thumb. Each end of the section should be cut at a 45 degree angle.

The cuttings must be kept moist. They should be transported within hours for transplanting into a moist seedbed. The preparation and transplanting of cuttings should coincide with the start of the rains or when soil moisture is reliable. Success of establishment by cuttings varies greatly with soil type and other environmental factors. Each DA should experiment with cuttings from a range of tree legumes in a variety of environments within his local area.

2) Grass cuttings/splits

Some grasses may be propagated using splits. Bunch type grasses such as Guinea grass and phalaris are suitable for propagation by splits. The grass should first be cut low before digging the roots and taking the splits.

Stoloniferous type grasses such as Rhodes grass may be propagated by using stolons. Mature stolons or runners with at least three nodes should be used. The stolon is then covered with soil, with only a small proportion exposed.
### ANNEX 1

#### FORAGE DEVELOPMENT STRATEGIES SUMMARY

<table>
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<tbody>
<tr>
<td></td>
<td>High</td>
<td>Good</td>
<td>Good</td>
<td>Moderate</td>
<td>Cut and Carry</td>
<td>Moderate</td>
<td>Nil</td>
<td>For fodder supplementation.</td>
</tr>
<tr>
<td>Undersowing/Interplanting</td>
<td>Very high</td>
<td>Very good</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Grazing, Cut and Carry</td>
<td>Low to Moderate</td>
<td>Low to Moderate</td>
<td>Mostly for maize/sorghum, improved soil fertility, forage supply.</td>
</tr>
<tr>
<td>Forage strips</td>
<td>Very high</td>
<td>Very good</td>
<td>Good</td>
<td>High</td>
<td>Cut and Carry</td>
<td>High</td>
<td>Very high</td>
<td>Stock control essential, link with dairying, fattening.</td>
</tr>
<tr>
<td>Oversowing</td>
<td>Low</td>
<td>Good</td>
<td>Poor</td>
<td>Low</td>
<td>Uncontrolled grazing</td>
<td>Very low</td>
<td>Nil-low</td>
<td>Very low input.</td>
</tr>
<tr>
<td>Mixed Pastures</td>
<td>Low</td>
<td>Good</td>
<td>Good</td>
<td>High</td>
<td>Closely controlled grazing</td>
<td>Moderate to high</td>
<td>Moderate to high</td>
<td>Mostly for dairying.</td>
</tr>
<tr>
<td>Improvement of Exclusion Areas</td>
<td>Medium to high</td>
<td>Very good</td>
<td>Poor to fair</td>
<td>Moderate</td>
<td>Cut and Carry</td>
<td>Low to Moderate</td>
<td>Moderate to High</td>
<td>Link with dairying, fattening.</td>
</tr>
<tr>
<td>Fodder Crop Production</td>
<td>Medium</td>
<td>Good</td>
<td>Good</td>
<td>Moderate</td>
<td>Cut and Carry</td>
<td>High</td>
<td>Nil</td>
<td>Mostly for dairying.</td>
</tr>
</tbody>
</table>
2.1 HAY REQUIREMENTS

<table>
<thead>
<tr>
<th>Animal</th>
<th>Kg. hay per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow</td>
<td>12</td>
</tr>
<tr>
<td>Heifer</td>
<td>9</td>
</tr>
<tr>
<td>Young dairy stock</td>
<td>4.6</td>
</tr>
</tbody>
</table>

2.2 HAY QUANTITY ESTIMATION

a. Rectangular Stacks

Cubic Capacity \[ (A \times B \times C) + (A \times B \times 0.5D) \] cubic metres

B. Round stacks

Cubic Capacity \( D \times D \times H \times \frac{6}{4} \) cubic metres

Then convert cubic metres to tonnes using the following table.

<table>
<thead>
<tr>
<th>Condition of Stack</th>
<th>Round Stack Cu.m. per quintal</th>
<th>Rectangular stack Cu.m. per quintal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not well settled (loose)</td>
<td>1.2 - 1.6</td>
<td>1.0 - 1.2</td>
</tr>
<tr>
<td>Moderately well settled</td>
<td>0.9 - 1.0</td>
<td>0.8 - 0.9</td>
</tr>
<tr>
<td>Very well settled (firm)</td>
<td>0.7</td>
<td>0.7</td>
</tr>
</tbody>
</table>
ANNEX 3

IMPORTANT NURSERY INFORMATION

3.1 LAYOUT:
- Width of beds: 1.2m (max)
- Width of walkways: 0.5m (min)
- Length of beds: 10m to 15m.

3.2 SIZE

Nursery Size Guidelines for 100,000 Potted Seedlings

<table>
<thead>
<tr>
<th>Pot size Diameter (cm)</th>
<th>Area of beds (m²)</th>
<th>Total area including fences, roads, etc. (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>250</td>
<td>1750</td>
</tr>
<tr>
<td>6</td>
<td>360</td>
<td>1080</td>
</tr>
<tr>
<td>7</td>
<td>690</td>
<td>1470</td>
</tr>
<tr>
<td>8</td>
<td>640</td>
<td>1920</td>
</tr>
</tbody>
</table>

Nursery Size Guidelines for 100,000 Bare-root Seedlings

<table>
<thead>
<tr>
<th>Spacing between seedlings (cm)</th>
<th>Area of beds (m²)</th>
<th>Total area including fences, roads, etc. (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 x 20</td>
<td>1000</td>
<td>2600</td>
</tr>
</tbody>
</table>
### 3.3 LABOUR SUPPLY

#### Nursery Labour Requirements per 100,000 Seedlings

<table>
<thead>
<tr>
<th>Activity</th>
<th>Labour input (man days per 100,000 Seedlings)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparing germination beds</td>
<td>5 - 15</td>
<td>Depends on bed size</td>
</tr>
<tr>
<td>Seeding</td>
<td>20 - 100</td>
<td>20 for broadcasting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100 for spot seeding</td>
</tr>
<tr>
<td>Plastic pot preparation</td>
<td>170 - 190</td>
<td>5cm x 15cm pots</td>
</tr>
<tr>
<td>Transplanting</td>
<td>110 - 130</td>
<td></td>
</tr>
<tr>
<td>Root pruning</td>
<td>40 - 50</td>
<td>Plastic pots only</td>
</tr>
<tr>
<td>Uplifting pots</td>
<td>30 - 40</td>
<td></td>
</tr>
<tr>
<td>Bare-root bed preparation</td>
<td>10 - 30</td>
<td>Varies according to bed size and spacing</td>
</tr>
<tr>
<td>Thinning bare-root seedlings</td>
<td>20 - 30</td>
<td></td>
</tr>
<tr>
<td>Uplifting bare-root seedlings</td>
<td>25 - 35</td>
<td></td>
</tr>
</tbody>
</table>
## ANNEX 4

### FORAGE SPECIES

#### 4.1 LIST OF MAJOR SPECIES, CULTIVARS, COMMON NAMES

<table>
<thead>
<tr>
<th>BOTANICAL NAME</th>
<th>COMMON CULTIVARS</th>
<th>COMMON NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tree legumes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leucaena leucocephala</td>
<td>Cunningham</td>
<td>Leucaena</td>
</tr>
<tr>
<td></td>
<td>Peru</td>
<td></td>
</tr>
<tr>
<td></td>
<td>K8</td>
<td></td>
</tr>
<tr>
<td>Sesbania sesban</td>
<td></td>
<td>Sesbania</td>
</tr>
<tr>
<td>Sesbania grandiflora</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sesbania formosa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chamaecytisus prolifer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gliricidia sepium</td>
<td></td>
<td>Tree Lucerne,</td>
</tr>
<tr>
<td>Gleditsia triacanthos</td>
<td></td>
<td>Tagasaste</td>
</tr>
<tr>
<td>Calliandra calothyrsus</td>
<td></td>
<td>Gliricidia</td>
</tr>
<tr>
<td>Prosopis spp</td>
<td></td>
<td>Honey locust</td>
</tr>
<tr>
<td>Acacia spp</td>
<td></td>
<td>Calliandra</td>
</tr>
<tr>
<td>Erythrina spp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other tree species</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salix spp.</td>
<td></td>
<td>Willow</td>
</tr>
<tr>
<td>Salix alba x S. matsudana</td>
<td></td>
<td>Hybrid willow</td>
</tr>
<tr>
<td>Alnus spp</td>
<td></td>
<td>Alder</td>
</tr>
<tr>
<td>BOTANICAL NAME</td>
<td>COMMON CULTIVARS</td>
<td>COMMON NAME</td>
</tr>
<tr>
<td>----------------</td>
<td>------------------</td>
<td>-------------</td>
</tr>
<tr>
<td><strong>Legumes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stylosanthes hamata</td>
<td>Verano</td>
<td>Caribbean stylo</td>
</tr>
<tr>
<td>Stylosanthes scabra</td>
<td>Seca</td>
<td>Shrubby stylo</td>
</tr>
<tr>
<td>Stylosanthes guianensis</td>
<td>Fitzroy</td>
<td>Stylo</td>
</tr>
<tr>
<td>Desmodium uncinatum</td>
<td>Graham</td>
<td>Silverleaf</td>
</tr>
<tr>
<td>Desmodium intortium</td>
<td>Cook</td>
<td>Silverleaf</td>
</tr>
<tr>
<td>Stylosanthes guianensis</td>
<td>Seca</td>
<td>Shrubby stylo</td>
</tr>
<tr>
<td>Desmodium uncinatum</td>
<td>Silverleaf</td>
<td>Desmodium</td>
</tr>
<tr>
<td>Desmodium intortium</td>
<td>Greenleaf</td>
<td>Greenleaf</td>
</tr>
<tr>
<td>Macrotyloma uniflorum</td>
<td>Archer</td>
<td>Uniflorum</td>
</tr>
<tr>
<td>Macrotyloma axillare</td>
<td>Siratro</td>
<td>Axillaris</td>
</tr>
<tr>
<td>Calopogonium mucunoides</td>
<td>Siratro</td>
<td>Calopo</td>
</tr>
<tr>
<td>Desmodium distortum</td>
<td>Siratro</td>
<td>Siratro</td>
</tr>
<tr>
<td>Desmodium discolor</td>
<td>Lablab</td>
<td>Lablab</td>
</tr>
<tr>
<td>Macrotyloma uniflorum</td>
<td>Miles</td>
<td>Lottononis</td>
</tr>
<tr>
<td>Macropogonium axillare</td>
<td>Wynn</td>
<td>Joint vetch</td>
</tr>
<tr>
<td>Calopogonium mucunoides</td>
<td>Miles</td>
<td>Pigeon pea</td>
</tr>
<tr>
<td>Macroptilium atropurpureum</td>
<td>Siratro</td>
<td>Berseem</td>
</tr>
<tr>
<td>Lablab purpureus</td>
<td>Siratro</td>
<td>White clover</td>
</tr>
<tr>
<td>Desmodium distortum</td>
<td>Safari</td>
<td>Kenya white clover</td>
</tr>
<tr>
<td>Desmodium discolor</td>
<td>Safari</td>
<td>Subterranean clover</td>
</tr>
<tr>
<td>Macroptilium atropurpureum</td>
<td>Miles</td>
<td>Strand medic</td>
</tr>
<tr>
<td>Lablab purpureus</td>
<td>Safari</td>
<td>Burr medic</td>
</tr>
<tr>
<td>Desmodium distortum</td>
<td>Safari</td>
<td>Lucerne, Alfalfa</td>
</tr>
<tr>
<td>Macroptilium axillare</td>
<td>Safari</td>
<td>Cowpeas</td>
</tr>
<tr>
<td>Calopogonium mucunoides</td>
<td>Miles</td>
<td>Vetch</td>
</tr>
<tr>
<td>Desmodium distortum</td>
<td>Safari</td>
<td>Blue pea</td>
</tr>
<tr>
<td>Lottononis bainesii</td>
<td>Safari</td>
<td>Tepary bean</td>
</tr>
<tr>
<td>Cassia rotundifolia</td>
<td>Safari</td>
<td></td>
</tr>
<tr>
<td>Aeschynomene falcata</td>
<td>Safari</td>
<td></td>
</tr>
<tr>
<td>Aeschynomene americanum</td>
<td>Safari</td>
<td></td>
</tr>
<tr>
<td>Cajanus cajan</td>
<td>Safari</td>
<td></td>
</tr>
<tr>
<td>Trifolium alexandrinum</td>
<td>Safari</td>
<td></td>
</tr>
<tr>
<td>Trifolium repens</td>
<td>Safari</td>
<td></td>
</tr>
<tr>
<td>Trifolium semipilosum</td>
<td>Safari</td>
<td></td>
</tr>
<tr>
<td>Trifolium subterraneum</td>
<td>Safari</td>
<td></td>
</tr>
<tr>
<td>Medicago littoralis</td>
<td>Safari</td>
<td></td>
</tr>
<tr>
<td>Medicago polymorpha</td>
<td>Safari</td>
<td></td>
</tr>
<tr>
<td>Medicago sativa</td>
<td>Safari</td>
<td></td>
</tr>
<tr>
<td>Vigna unguiculata</td>
<td>Safari</td>
<td></td>
</tr>
<tr>
<td>Vicia dasycarpa</td>
<td>Safari</td>
<td></td>
</tr>
<tr>
<td>Clitoria ternatea</td>
<td>Safari</td>
<td></td>
</tr>
<tr>
<td>Phaseolus acutifolius</td>
<td>Safari</td>
<td></td>
</tr>
<tr>
<td>Botanical Name</td>
<td>Common Cultivars</td>
<td>Common Name</td>
</tr>
<tr>
<td>---------------</td>
<td>----------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Grasses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panicum maximum</td>
<td>Common</td>
<td>Guinea</td>
</tr>
<tr>
<td>P. maximum var. trichoglume</td>
<td>Gatton</td>
<td>Gatton panic</td>
</tr>
<tr>
<td>Panicum coloratum</td>
<td>Bambatsi</td>
<td>Hamil guinea</td>
</tr>
<tr>
<td>Panicum antidotale</td>
<td>Pollock</td>
<td>Green panic</td>
</tr>
<tr>
<td>Paspalum plicatulum</td>
<td>Rodds Bay</td>
<td></td>
</tr>
<tr>
<td>Chlors gayana</td>
<td>Blythe</td>
<td></td>
</tr>
<tr>
<td>Cenchrus ciliaris</td>
<td>Hartley</td>
<td></td>
</tr>
<tr>
<td>Clenchrus ciliaris</td>
<td>Callide</td>
<td></td>
</tr>
<tr>
<td>Selaria spinacea</td>
<td>Samford</td>
<td></td>
</tr>
<tr>
<td>Festuca arundinacea</td>
<td>Bilgela</td>
<td></td>
</tr>
<tr>
<td>Phalaris aquatica</td>
<td>USA</td>
<td></td>
</tr>
<tr>
<td>P. aquatica x P. arundinacea</td>
<td>Molopo</td>
<td></td>
</tr>
<tr>
<td>Dactylis glomerata</td>
<td>Gayndah</td>
<td></td>
</tr>
<tr>
<td>Pennisetum clandestinum</td>
<td>Kazungula</td>
<td></td>
</tr>
<tr>
<td>Pennisetum purpureum</td>
<td>Narok</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nandi</td>
<td></td>
</tr>
<tr>
<td>Fodder Grops</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avena sativa</td>
<td>Porto</td>
<td>Benku</td>
</tr>
<tr>
<td>Beta vulgaris</td>
<td>Currie</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Apanui</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Whittet</td>
<td></td>
</tr>
</tbody>
</table>
A wide range of exotic forage species are potentially very useful for Ethiopia. A large number of species must be considered because of the wide range of altitudes, soils, rainfall, existing management systems, and forage development strategies.

It is important for Development Agents to closely observe the performance of a range of species within their area. Skills will be developed, in deciding which species are best for a particular situation.

The information provided in this Annex should be seen as a guide only. Extension workers must understand that a flexible approach is required, because it is not possible to exactly predict species performance for every site. Local experience is essential. Also, information from literature from other countries must be interpreted cautiously... particularly for altitude limits.

Extension workers should assess sites according to the characteristics which will have most influence on species performance. The key factors are

a) Altitude, frost incidence.

b) Rainfall, total annual rainfall, length of growing season, pattern (one or two wet seasons).

c) Soil - especially soil pH, depth, texture (clay, sandy etc.), seasonal waterlogging, salinity.

d) Slope.

e) Present level of degradation, erosion.

f) Present vegetative cover.

g) Grazing pressure.

h) Level of livestock control possible.

i) Proposed forage development strategies.

j) Proximity to source of seedlings, grass splits etc.
Species characteristics which are important are:-

a) Growth potential at the particular site.
b) Ease of establishment.
c) Tolerance of cutting or grazing, and regrowth potential.
d) Persistence.
e) Palatability and feeding value (lower palatability can sometimes be a major advantage, especially in sites with poorer control of livestock); seasonal pattern of feeding value.
f) Compatibility with other species which might be grown in the same area.
g) Seasonal growth pattern .. ability to continue growth into the dry season is often very important.
h) Additional benefits including fuel wood production and production of human food.
j) Seed production ability, under good management, to enable bulking up of seed.
k) Ability to produce seed and spread under normal grazing or management conditions.

4.2.2 TREE AND SHRUB LEGUMES

The tree legumes can be extremely important in forage development programmes.

a) They may produce large quantities of forage.
b) They are deep-rooted, and with correct management can produce green feed for much of the dry season.
c) The feeding value of the leaves and finer stems is as high as most herbaceous legumes. The production of edible pods/seeds is often very high.
d) They combine well with some grasses and herbaceous legumes.
e) They can have a major role in providing nitrogen and organic matter for soil fertility improvement eg. in alley farming systems.
f) They may have benefits as shelter belts around and within crop areas.
g) In some cases they can provide useful fencing.
h) Fuel wood production from tree legumes within farm environments may meet most or all of a household’s fuel requirements.
i) Some species may provide useful building poles.
LEUCAENA

Leucaena leucocephala

A long-lived perennial shrub or tree legume. Multi-purpose. Excellent for forage production, fuel wood, soil stabilization, and nitrogen fixation. Ethiopia has a mixture of cultivars, which is a possible advantage. Leucaena is the world’s major fodder tree.

Adaptation :

Altitude : Often productive to 2000m, but better at lower altitudes. May try some plantings to 2200 m, on very favourable sites. Quite sensitive to frost, especially when young.

Rainfall : No upper limit. Quite drought tolerant. Will grow and persist even at 400mm, but may drop leaves in dry season.

Soils : Plant on well drained soils only. pH should be about 6.0 or above for best results. Extremely productive on deep, fertile, well-drained soils.

Cutting/browsing : Well adapted to cutting/browsing once well established. Will coppice (regrow) very well when cut to any height.

Establishment :

Hot-water treatment of seed necessary for good germination. Inoculation with specific Rhizobium very important. Direct seeding or seedlings. Bare stem seedlings have good survival. Try to plant seedlings at least 70-80 cm tall. Establish very early in wet season. Cuttings successful on some soils only. Direct seeding at up to 50 seeds/metre for erosion control. 0.5metre spacing between seedlings suitable in alleys or other hedges.
Utilization:

Protection from livestock crucial for high production. Use for cut and carry. Cut every 6-8 weeks at 80-100 cm. May cut lower in alley farming. Use as a supplement (20-30%) to crop straws etc. Feed green or as dried leaf. No toxicity problems if less than 50% of diet. Extremely palatable. Use excess forage as mulch. Wood has good burning properties. Leaf meal potentially very valuable cash crop. Ground seed or leaf meal suitable for poultry.

Seed Production:

Seeds very heavily. One man can harvest 5-10kg per day. Potential production probably 50-100kg per 100 metres of hedge.

Suitable systems/strategies:

Hedge systems with good control of livestock. Alley farming, bund planting, backyard forage.

Major cultivars:

Cunningham, Peru — for forage, fuel wood, stabilization. Well branched. Coppice well.

Hawaiian giants (eg K8) — Very tall growing in higher rainfall. For forage, fuelwood, poles. Coppice well.

Sesbania sesban

A useful shrub or tree legume for forage, soil stabilization, and nitrogen fixation. A wide range of adaptation, and a wide range of genetic material. Usually relatively short-lived (about 6-7 years).

Adaptation:

Altitude: Will grow to 2500-2600m. Quite productive to 2300-2400m. Very frost sensitive, especially when young.

Rainfall: Not as drought tolerant as Leucaena. Will grow down to 600-700mm.

Soils: Very versatile. Will grow on a wide range of soils, including heavy, waterlogged soils and moderately infertile soils. Sesbania does not require inoculation.

Cutting/browsing: Quite tolerant of cutting, browsing.

Establishment:

Seedlings more vigorous than those of Leucaena. Direct seeding recommended for all situations. Seed very early (at onset of first rains).

Sow at up to 50 seeds per metre for continuous hedge, or 2-3 seeds per hole at 0.5m. spacing.
Protect hedges from livestock. Mainly for cut and carry. Cut at 0.5-1.0m height, at 6-8 weeks interval. (Has low leaf-stem ratio with less frequent cutting). Use as a supplement (20-30%) with crop residues etc. Palatable. No toxicity problems. Feed green or as dried leaf. Use excess forage as mulch. Wood has only moderate burning quality.

May have severe insect damage of seedlings and older plants, especially when large numbers are grown in the same area.

Seeds heavily over a long period. One man can easily harvest 3-5kg/day. Seed production probably 50-100kg per 100m of hedge.

Suitable systems/strategies:

For hedge systems. Back-yard forage, bund planting, contour planted strips, alley farming.

Related species:

Sesbania formosa, Sesbania grandiflora. Tall, fast growing species in higher rainfall areas.
GLIRICIDIA

Gliricidia sepium

A very useful tree legume for lower altitudes. Multi-purpose. Major species for alley farming in West Africa. In Ethiopia will be suited mainly to higher rainfall areas in west.

Adaptation:
Little known about adaptation in Ethiopia.

Altitude: Mainly for lower altitudes. Probably productive to about 1800m.

Rainfall: Typically more than 900-1000mm. Some lines will adapt to lower rainfall. It sheds leaves with moisture stress.

Soils: Will grow on much less fertile soils than Leucaena, including quite acid soils; prefers good drainage.

Cutting/browsing: Suited to cutting more than browsing. Coppices very well, when cut at any height.

Establishment:
Establishment by cuttings preferred. (Grow a few trees in convenient locations for supply of cuttings.) Direct seeding can be used. Plant cuttings close together eg. 25cm spacing, for living fence, and intertwine branches for stock proofing; 0.5m spacing between plants for alley farming.

Management and Utilisation:

Palatability lower than Leucaena and Sesbania. Therefore less protection from livestock required. Mix with other feed stuffs until stock become familiar with it. Palatability increased by cutting and drying. Feeding value quite high. Cut regularly eg. 6-8wks, to any convenient height. Fuelwood of only moderate burning value.

Seed production:

Seed production usually difficult in Ethiopia. Collect pods before fully ripe. Cuttings very convenient, so poor seed production not a problem.

Suitable systems/strategies:

Excellent living fence, excellent for alley farming. Lower palatability can be a great advantage.
(TAGASASTE)
Chamaecytisus prolifer

An extremely useful tree legume with a very wide range of adaptation.

Adaptation:

Altitude: Very wide altitude range, from low to 3200 metres plus. Tolerates very low temperature and frosting. Continues growing throughout year once well established.

Rainfall: It grows over a wide rainfall range, and is extremely drought tolerant once established.

Soils: It will tolerate relatively infertile and acid soils; must have good drainage.

Cutting/browsing: Adjusts well to either cutting or browsing when established. Coppices very well.

Establishment:

By direct seeding or transplanted seedlings. Early growth slow, so weeding important during first growing season. Establish very early in growing season. Spacing generally 30-50cm between plants. Seed should be treated in boiling water for 5-10 minutes. Inoculate if possible.

Management/Utilization:

Allow plants to establish well during first year. Commence cutting in second year. Every 6-8 weeks at about 1 metre height. Mix cut forage with crop residues etc. Coppicing excellent. Fuel wood value moderate only.

Seed production:
Seeds very heavily at all altitudes once well established. Seed yield up to 0.5kg per tree.

Suitable systems/strategies:
Back yard forage, higher altitude alley farming, forage strips, windbreaks, stock exclusion areas (good colonising ability).
PIGEON PEA

Cajanus cajan

A very versatile multipurpose leguminous shrub; short lived perennial, suited to a wide range of environments. Wide genetic range including daylength sensitive and insensitive lines. Some lines will mature very early.

Adaptation :

Altitude: From lowlands to 2600m plus where not affected by frost.

Rainfall: Extremely drought tolerant. Some lines will mature with 250-300mm rain.

Soils: Suited to a wide range of soils, light to medium textured preferred. Avoid water logging.

Cutting/Browsing: Suited to occasional lenient cutting/browsing. Moderate to good regrowth ability.

Establishment:

Sow in strips on well prepared seedbeds. Sowing depth 2-4cm. Very early sowing preferred. Early weed control important. For high grain yield, sowing rate about 20-25kg/ha.

For strip planting forage and for grain, sow at about 1kg/km of strip. Intercrop with maize, substitute some rows of maize with pigeon pea eg. every third row, or every fifth row. May also be planted in forage strips with slower growing tree legumes to provide early forage and early visual impact.

Management/Utilization:

Cut 2-3 times during growing season, for forage. Do not cut low. In interplanted systems, allow pigeon pea to mature on residual moisture after harvest of companion crop. Cut back after harvest of seed. Will ratoon well for 2-3 years. Forage sufficiently palatable and of good nutritive value.

Seed Production:

Seed yields of 3000kg/ha plus are possible. Most seed will be collected from strips. Shattering not a problem.
Suitable systems/strategies:

Suited to strip planting eg. to complement tree legumes in alley farming and on contour strips. Well suited to intercropping with maize/sorghum. (Increases reliability of food production - food security - because of extreme drought tolerance). Useful as windbreak, component of hedges around houses and crop areas.

OTHER FORAGE TREE AND SHRUB SPECIES

ERYTHRINA

Erythrina abyssinica, Erythrina brucei.

An excellent tree legume species for living fences, and low quality forage. Coppices well. Will grow to 3,000m. Establish by cuttings. Close plant along fenceline, eg 30cm spacing. Already popular in many areas.

CALLIANDRA

Calliandra calothyrsus

A promising tree legume for alley farming and other forage strips. Also stock exclusion areas. Coppices well. Will grow probably to 2400m or more. Establish by direct seeding or cuttings. Less palatable than Leucaena or Sesbania.

WILLOW

Salix spp.

Including salix alba X Salix matsudana - Hybrid willow

Not a legume, but quite high in nutritive value. Some lines coppice extremely well. Useful for fodder, fuel wood, as a windbreak, and in erosion control, in some highland areas. Willow forage will assist in fluke control in sheep and cattle.

May defoliate in winter and with extreme moisture stress. Tolerates very poor drainage. pH should be 6.3 - 7.0. Establish by cuttings about 25cm long and 2cm thick. Place cuttings in bucket of water for 3 days before planting. Plant at angle, most of cutting buried. Establish in strips, cuttings 25-50cm apart.

DISTORTUM

Desmodium distortum

An erect perennial legume growing to at least 2m height. May be useful to 2000m altitude, range of soils, rainfall at least 800mm. Ideal for strip planting, eg. on bunds, for intensive cut and carry management. Similar species: Desmodium discolor, Codariocalyx gyroides.
4.2.3 HERBACEOUS LEGUMES

The herbaceous legumes are used in undersowing, oversowing of grazing areas, improvement of stock exclusion areas, in mixed pasture establishment, and to a small extent in back yard forage plots. Establishment is always by direct seeding. Therefore only those species with good seed production capacity, and ease of seed production will be of major importance. In most cases ease of establishment is also a key factor in selection.

THE STYLOS

The stylos are very useful because they are often extremely hardy, and will grow on soils of very low phosphate status and on some quite acid soils. Palatability is variable, but always increases during the dry season when the plants 'hay off'. Most stylos establish readily by surface sowing even on rough seed beds. Burying seed may prevent germination. Most are tolerant of heavy grazing pressure, and some will set seed and spread even under severe grazing. Stylosanthes fruticosa is native to many parts of Ethiopia. The main stylos to be used in Ethiopia will be:

CARIBBEAN STYLO.... Stylosanthes hamata cv. Verano
SHRUBBY STYLO ..... Stylosanthes scabra cv. Seca
PERENNIAL STYLO....Stylosanthes guianensis cv. Graham, cv. Cook
FINE STEM STYLO.... Stylosanthes guianensis cv. Oxley

Verano is a short-lived perennial plant. The rest are generally much longer lived. Under suitable Ethiopian conditions typical maximum growing heights will be:- Verano 20-30cm, Oxley 30cm, Graham, Cook 50-60cm, Seca 150cm.

Adaptation:

Altitude: Generally to about 2000m. Oxley more cold tolerant than others.

Rainfall: Oxley, above 800mm; Graham above 600-700mm; Verano, Seca generally need above 500mm.

Soils: Stylos generally thrive on poor, sandy, acid soils. Tolerate very low P levels. Prefer good drainage. Verano is the most adaptable, will grow well on acid or alkaline soils.
Cutting/Grazing: Seca, Verano tolerate very heavy grazing, and continue to seed. Graham and Oxley quite tolerant. Cook less tolerant of continued grazing than Graham because it seeds later and not heavily.

Establishment:

Seed should be heat treated (especially Seca, Verano). Usually inoculation not necessary. Generally broadcast on surface at low seeding rates, eg. 1kg/ha for oversowing, 2kg/ha for undersowing. Establishment and early growth assisted by controlling companion grasses by grazing.

Management/Utilization:

Because of grazing tolerance, good management not necessary. Usually better under grazing than with livestock exclusion. Because of relatively low feeding value, usually not suited to intensive cut-and-carry. Seca is least palatable, very hardy.

Seed Production:

Verano: seeds heavily, (up to 1500kg/ha) over a long period, harvest by sweeping from ground during early dry season. (Seed is swept from ground with brooms, then sieved, and finally winnowed. Soils which compact in dry season, but do not crack, are ideal.)

Graham: seeds moderately heavily, over a long period. Harvest by cut and thresh, or sweeping from ground.

Cook: seeds more lightly, with a restricted flowering period.

Seca: seeds moderately (about 200-400kg/ha), but is usually slow to flower in first season; harvest by cut-and-thresh, beating seed from bush, or sweeping from ground.

Oxley: seeds moderately, harvest by cut and thresh.

Suitable systems/strategies:

Undersowing (for early seeding types), oversowing, improvement of exclusion areas, mixed pastures.

Disease:

Some stylo lines seriously affected by fungal disease anthracnose. Verano, Seca tolerant. Most S. guianensis moderately susceptible.
THE CLIMBING/SPRAWLING TROPICAL AND SUBTROPICAL LEGUMES

These legumes will have a major role, mostly in undersowing and stock exclusion area improvement. Generally the plants are weakened by repeated cutting or grazing close to the ground. With most, better management is required for maintained production. The main species in the perennial group are:

SIRATRO Macroptilium atropurpureum cv Siratro
AXILLARIS Macrotyloma axillare cv Archer
GLYCINE Neonotonia wightii cv Tinaroo
GREENLEAF Desmodium intortum cv Greenleaf
SILVERLEAF Desmodium uncinatum cv Silverleaf
CALOPO Calopogonium mucunoides.

Adaptation:

Altitude: Common upper limits for reasonable production.

Siratro: 2000-2100m
Axillaris: 2200-2400m
Glycine: 2200-2300m
Silverleaf: 2100-2200m
Greenleaf: 2200-2300m
Calopo: 1600-1800m
Rainfall:
Common lower limits for reasonable production.
- Siratro: 500-600mm
- Axillaris: 500-600mm
- Glycine: 600-700mm
- Silverleaf: 800-900mm
- Greenleaf: 700-800mm
- Calopo: 700-900mm

Soils:
Generally, avoid waterlogging. Siratro, Axillaris, Calopo adapted to wide range of soils, including low fertility sandy soils. Desmodiums and Glycine require higher fertility.

Cutting/Grazing:
Repeated low cutting will kill or weaken plants. Continuous light grazing does little damage.

Palatability:
- Siratro: Moderate palatability, increasing with age.
- Axillaris: Low-moderate palatability, increasing with age; may need a familiarisation period.
- Glycine: Palatable.
- Desmodiums: Palatable.
- Calopo: Very low palatability until cut and dried, or hayed off (hence excellent for soil stabilisation).

Establishment:
Glycine and Desmodiums require moderate seed bed. Siratro, Axillaris, Calopo establish very readily even on some undisturbed soils. Sowing rates from 0.5-2.0kg/ha.

Management/Utilization:
Continuous moderate grazing much better than occasional very heavy grazing. Allow to seed at least in first season. If cutting, do not cut too low.

Seed Production:
All these species seed more heavily if climbing on trellis. Siratro best and easiest for seed production (more than 1500kg/ha possible from trellis). Others seed heavily, but more restricted seeding period, and more difficult to collect.

Suitable systems/strategies:
Exclusion areas, mixed pastures (except for calopo), undersowing (except Calopo), oversowing (except Glycine and Desmodiums). Suitable ground cover in plantation crops, and in forestry areas if tree spacing is sufficiently wide.
**Lablab purpureus**

A vigorous annual or short-lived perennial legume suited to a wide environmental range. Seedlings very vigorous, later forming long trailing or climbing stems.

**Adaptation :**

Altitude : From low altitudes to about 2400-2500m. Moderately tolerant of frost.

Rainfall : Very drought resistant. Useful even in 400mm rainfall.

Soil : Suited to a wide range of soils; intolerant of flooding and salinity.

Cutting/Grazing : Quite tolerant of occasional leaf removal or lenient cutting.

**Establishment :**

Large seeded. Establishes easily even on rough seedbeds; Sow 18-20 kg/ha for pure stand, 15 kg/ha undersown, 2kg/km of bund or forage strip. Cover seed.

**Management/Utilization :**

Graze rotationally but not heavily. Avoid cutting below 25-30cm. May require several days for cattle to accept it initially. Use to supplement other feeds. Dual purpose. Grain excellent human food; widely used in Kenya.

**Seeding :**

Seeds heavily, seeds formed above canopy, easily collected. Expected yields 500-1000kg/ha. Trellising increases yields. Seed production from undersowing (early planted) convenient.

**Suitable systems/strategies :**

Mainly undersowing. Some bund planting with other vigorous species. Excellent pioneer species/green manure/improvement of fallow areas. Pioneer component of pasture mixes, at low seeding rates. Can be promoted as dual purpose species.
Vigna unguiculata

An annual dual purpose legume suited to a wide environmental range. Very diverse genetic material. Some very quick maturing lines.

Adaptation:

Altitude: From low altitudes to about 2400-2500m.

Rainfall: Extremely drought tolerant. Some lines mature with less than 200mm rain.

to light sandy soils.

Cutting/grazing: Will tolerate several lenient defoliations by cutting or grazing during the growing season.

Establishment:

Will establish on fairly rough seedbed. Sow at 15 kg/ha pure stand, 12kg/ha undersown. Will be established mostly undersown in maize and sorghum.

Management/Utilization:

Will generally be utilised after host crop is harvested, by cutting or grazing. Preferable to collect some seed first for sowing in following season. Seed is excellent human food.

Seed production:

Yield 500-800kg/ha. Seed collection from undersown areas (early planted) is most convenient.

Suitable systems/strategies:

Very convenient species for undersowing, for forage, green manure, human food.
VETCH

*Vicia dasycarpa*

A vigorous climbing/sprawling annual legume with a very wide range of adaptation. Potentially of enormous importance to Ethiopia.

**Adaptation:**

Altitude: Suited to all altitudes from 1500m to 3000m plus.

Rainfall: Suited to a wide rainfall range. May mature even with 400mm rainfall.

Soils: Will grow on soils from vertisols to light sandy soils.

Cutting/grazing: Good regrowth ability, especially after lenient cutting or grazing. Also well suited to one cut at end of season.

**Establishment:**

Establishes readily even on rough seedbeds. Sowing rates 20kg/ha for pure stand, 12kg/ha undersown, 5-12kg/ha as pioneer component of pasture mix, 12-20 kg/ha sown with oats.

**Management/Utilization:**

Generally used in undersowing. May be cut low and fed to stock earlier in host crop growth, but should be allowed to mature and seed before crop harvest or before vetch is cut or grazed off after crop harvest. Self-regenerating.

**Seed Production:**

Seeds quite heavily, but shattering occurs. Yields commonly 400-1000kg/ha, higher if allowed to climb on fences etc. Undersown vetch in maize and sorghum very suitable for seed production if vetch is sown early.

**Suitable systems/strategies:**

Very reliable species for undersowing in maize, sorghum, other crops. Excellent in mixture with oats. Good pioneer species, good for improvement of soil fertility. Can improve fallow areas if protected from grazing.
CASSIA
Cassia rotundifolia
An adaptable low growing perennial legume with low management requirements.

Adaptation:
Altitude: From low altitude rangelands, at least to 2,300m.
Soils: Grows on a wide range of soils.
Cutting/grazing: Tolerates heavy grazing pressure. Only moderate palatability.

Establishment:
Establishes readily by oversowing/undersowing. Use low seeding rates eg. 2-3k/ha.

Management:
No requirement for good management. Will seed and spread even under grazing.

Seed Production:
Seeds quite heavily. Probably 200-400kg/ha. Seed collection simple but tedious; pluck ripe pods.

Suitable systems/strategies:
Suites to undersowing wide range of crops; oversowing; improvement of stock exclusion areas.

LOTONONIS
Lotonomis bainesii cv. Miles. A useful low-growing perennial legume.

Adaptation:
Altitude: Probably best 1500-2300m. Tolerant of frost.
Rainfall: Generally above 800mm. May behave as annual with very long dry season.
Soils: Adaptable, but best on light sandy soils. Tolerant of water logging.
Cutting/grazing: Generally too low growing to suit cutting; very tolerant of grazing. Very low seeding rates eg. 1kg/ha if sole legume species, 0.1-0.2kg/ha in mixture. Will spread naturally. Inoculation of seed essential.

Management/Utilization:
In mixed pasture, control grass competition by grazing. Will seed under grazing, but best if withhold stock at flowering. Extremely palatable, good feeding quality. Use mostly for grazing.

Seed Production:
PASCUORUM

**Centrosema pascuorum**

A vigorous annual legume, well suited to seasonally waterlogged areas. Combines well with grasses. Seeds very heavily. Possibly useful to 1900-2000m.

UNIFLORUM

**Macrotyloma uniflorum cv Leichhardt**

A vigorous annual legume. Suited to forage or human food. Probably to 2200 metres altitude. Seeds very heavily. Suited to light soils, and heavier soils with good internal drainage. Easily established. Regenerates naturally. Useful for undersowing (dual purpose), and improvement of exclusion areas.

TEPARY BEAN

**Phaseolus acutifolius**

A very quick maturing annual legume. Dual purpose. Produces seed even with very late sowing. Suitable human food. Undersow in maize and sorghum late in season. Suitable for some cropping areas with marginal rainfall.

DESMANTHUS

**Desmanthus virgatus**

A perennial legume. Prostrate and erect lines. Suited to range of soils, to altitudes of 1800-2000m, 700-800mm rainfall. Seeds very heavily. Probable use for strip planting eg. on bunds. Erect lines excellent for cut and carry. May also be useful in some exclusion areas.

CLITORIA

**Clitoria ternatea**

A perennial climbing legume, well suited to vertisols at lower altitudes.

Very palatable, and may disappear under close grazing. Seeds heavily.
ALFALFA OR LUCERNE

Medicago sativa

Common cultivars: Hunter River, Hairy Peruvian, Siriver, Paravivo, Sequel

A long lived perennial legume. Highly nutritious. Very productive under good management.

Adaptation:

Altitude: From low altitudes to 3,000m plus. Tolerant of extremely hot, extremely cold temperatures. Very frost tolerant.

Rainfall: Very deep rooted, quite drought tolerant when well established. Requires 600mm for good production. Ideal for irrigation.

Soils: Suited to a range of soils, but prefers good drainage. Very high production on deep, fertile, well drained soils. Avoid very low pH soils.

Cutting/Grazing: Adapted to rotational management systems.

Establishment:

Inoculate seed where possible. Sow on well prepared seedbed, 8–10kg/ha pure stand, 5–6kg/ha in mixture. Early weed control essential. Row planting has advantages. Sow at depths of 0.5–1.0cm on heavy soils, 1.0–2.0cm on light soils.

Management/Utilization:

Cut at 30–40 day intervals during the growing season; avoid damage to crown. Keep area weed free. Alternative guideline - cut at about 10% flowering. If grazing, graze on strictly rotational system, 30-40 day intervals. Best to use cut feed as supplement (eg.20-30%) to lower quality feedstuffs. Very high feeding value.
Seed Production:

Difficulties in Ethiopia. Try to establish seed production areas with bee-keeping units to aid pollination. Row planting or wider spacing will increase yields. Probable yields are 100-300kg/ha.

Suitable systems/strategies:

Excellent for small intensively managed plots, especially if irrigation is available. Also for more extensive mixed pastures, provided management is good.

CLOVER

Trifolium spp.

Ethiopia has very wide range of useful Trifolium spp. particularly above 2,000m altitude. These include T.decorum, T.quartinianum, T.sempilosum, T.tembense, and T.burchellianum. A common weakness of most of these species is that production stops almost immediately at the end of the wet season. There is some chance of improved production by introducing species which will provide good quality feed for part of the dry season i.e. these will continue to grow into the dry season, or will hold their leaf into the dry season. Species which will be tried in a range of environments in Ethiopia include:-

- **Trifolium repens**
  - White clover
  - A versatile, relatively drought tolerant, heat tolerant cultivar such as Haifa could be useful.

- **Trifolium Subterraneum - Subterranean clover or sub clover**
  - An annual clover, very tolerant of low rainfall, tolerant of very acid soils, but will grow on wide range of soils. Tolerates very heavy grazing. Dry stems, leaves, burrs excellent dry season feed. May combine well with cereal crops. Could be very useful in areas where it seeds successfully.

- **Trifolium pratense - Red clover**
  - Possibly useful in some well managed dairy pastures. But usually relatively short-lived. The cultivar Redquin should be more persistent.

MEDICS

Medicago spp.

Ethiopia has a range of useful medics, the most important being Medicago polymorphana. The medics are typically suited to neutral to alkaline soils. Occasionally cultivars of some medic species will be introduced into field testing and development programmes in the Ethiopian highlands. These could include cultivars of Barrel Medic (Medicago truncatula), Snail Medic (Medicago scutellata), and Strand Medic (Medicago littoralis).
The grasses are of less importance than the legumes in forage development in Ethiopia. They would be used mostly in back yard forage plots, in some strip planting, and in mixed pastures for dairy production. Because their major use is in relatively small intensive areas (back yards and strips), establishment by splits is often feasible. Poor seed production does not create the same problems as with the legume species, and completely sterile types can also be very useful in some situations.

Grasses are generally of lower protein content than the legumes, and protein declines quite rapidly with maturity. This is particularly so with the tropical/sub-tropical species. It is important, therefore, to cut or graze the grasses regularly to avoid excessive maturity. It is also very important to feed legumes with lower quality grasses.

**ELEPHANT GRASS**

**Pennisetum purpureum.**

An extremely vigorous tropical/sub-tropical grass suited to intensive management in high fertility situations.

**Adaptation:**

- **Altitude:** From low altitude to 2300m for good production. Moderately productive to 2500m plus in some areas. Moderately tolerant of frost.
- **Rainfall:** For good production at least 800mm. Quite drought tolerant.
- **Soils:** Suited to a wide range of soils, but avoid waterlogging. Requires continued manuring for

**Cutting/grazing:** Best suited to frequent cutting. Rapidly becomes rank, unpalatable, of low nutritive value. Heavy grazing over a long period will greatly weaken stand.

**Establishment:**

Plant by cuttings. For intensive forage areas plant in rows 1m apart, 50cm between cuttings, to allow establishment of companion legumes. Establish close to source of manure eg. beside livestock corral. For erosion control, closer planting eg. 30cm between cuttings in strip.
Management/Utilization:

Essential to cut regularly eg. cut to height of 50cm every 3-4 weeks during season. Do not allow it to become rank. Nutritive value satisfactory if cut regularly. Cut and hand feed to animals tethered nearby. Apply as much manure as possible. Extremely high yields possible from well managed, well fertilised areas.

*Dwarf Elephant Grass* will be widely used in Ethiopia. It is highly productive, but has higher nutritive value than common elephant grass, and nutritive value does not decline so quickly, or to such an extent, with age.

Suitable Systems/Strategies:

Excellent for small back-yard forage plots with good management. Also very good for erosion control with gully planting or contour strip planting.

**RHODES GRASS**

*Chloris gayana*

An extremely valuable grass for a range of environments and strategies. Strongly stoloniferous.

Adaptation:

Altitude: 102200 2400m.

Rainfall: Minimum 500-600mm.

Soils: Widely adaptable. Will tolerate salinity.

Grazing/Cutting: Tolerant of severe defoliation.

Establishment:

Well prepared seed bed preferred, but will establish even on a rough seedbed. Cover seed only lightly with soil. Use low seeding rates (because of vigorous spreading habit) eg. less than 1kg/ha in exclusion areas, 2-3kg/ha in mixed pastures. Combines well with many erect and climbing legumes. Do not plant in arable areas.
Management:

Manage sward to maintain legume component, and grass quality. Frequent lenient defoliation is preferred. Generally cut before seeding.

Seed Production:

Important to synchronise seed production. Slash areas, fertilise. 2-3 harvests possible, more with irrigation. Slash or graze heavily immediately after each harvest. Yield potentially 40-150kg/harvest.

Suitable systems/strategies:

For mixed pastures, exclusion areas, gully control, some back yard plots.

Cultivars:

Callide is a very productive and versatile cultivar for most areas. Use Samford or similar cultivar at higher altitudes (eg. above 2100m).

GUINEA GRASS, GATTON PANIC

Panicum maximum

Erect bunch type grasses, very productive in suitable environments with good management. Combine well with climbing legumes.

Adaptation:

Altitude: To about 2000m. Frost sensitive. Growth slow in cooler areas.

Rainfall: Require about 900mm for good production, but quite drought tolerant.

Soils: Adapt to wide range of soils. Very productive only on well drained fertile soils. Will tolerate some waterlogging.

Cutting/grazing: Very tolerant of cutting and regular grazing.

Establishment:

Sow on well prepared seed bed, 1-2kg/ha in mixture, 3-4kg/ha in pure stand. Preferable to sow with legumes. Shade tolerant...can establish under tree cover eg. good companion for tall Leucaena. If planting by splits, use spacing of 30-40cm.
Management:
Cut or graze regularly to prevent grass becoming rank. Keep well fertilised with manure in small backyard plots.

Seed Production:
Try to synchronise flowering by cutting or grazing heavily after each harvest, then fertilise. 2-3 harvests per season (rainfed). Up to 100kg per harvest with adequate fertiliser nitrogen.

Suitable systems/strategies:
Mainly for intensive cut and carry systems eg. small backyard plots with heavy manuring. Also for strip planting, and some mixed pasture.

Cultivars:
Hamil: very vigorous, tall growing, well suited to cut and carry.

Gatton panic: adaptable; more cold tolerant than Hamil, better suited to grazing than Hamil; also good for cut and carry. Good quality.

GREEN PANIC
Panicum maximum variety trichoglume
A useful, good quality bunch type grass suited to better soils; mainly for dairy pasture areas.

Adaptation:
Altitude: To 2200m plus. Moderately frost tolerant.

Rainfall: From very high rainfall areas, to about 500mm. Quite drought tolerant (more than Rhodes grass).

Soils: Versatile, from sandy soils to clays. Grows well on vertisols.

Cutting/grazing: Adapted to continual lenient cutting/grazing, or occasional very severe cutting/grazing.
Establishment:
Seed quality improves after storage eg. for 6 months. Well prepared seed bed preferred. Sow at about 1-3kg/ha in mixture. Combines well with many legumes. Very shade tolerant, so can be grown eg under tree legumes.

Management:
Manage sward to maintain legume component. If grazing pressure is moderate, Green Panic is quite persistent. Keep well fertilised with manure or chemical fertiliser. Very quick to show signs of N deficiency - leaves become pale.

Seed Production:
As for other Panicum spp.

Suitable systems/strategies:
Mainly as a component of mixed pastures for dairy production.

BAMBATSI or MAKARIKARI GRASS
Panicum coloratum variety makarikariense
A widely adaptable grass with good potential for mixed pastures in dairy programmes.

Adaptation:
Altitude: To 2300-2400m. Continues growth at quite low temperatures. Tolerant of frost.
Rainfall: Productive with higher rainfall. Persists with 400mm rainfall. Highly tolerant of seasonal droughts.
Soils: Versatile. Very good on vertisols. Tolerates salinity. Persists very well with seasonal waterlogging or flooding.

Cutting/Grazing: Very tolerant once well established.

Establishment:
Sow on well prepared seed beds, 2kg/ha in mixture; cover seed. Germination often low. Initial seedling growth slow. Therefore avoid heavy grazing early. Establishment also by rooted cuttings.

Management/Utilization:
May graze heavily once established. Feeding value retained reasonably well with age. Combines well with range of legumes. Adjust grazing mainly to maintain good legume content.

Seed Production:
Mixture of lines desirable for good seed setting. Seed production difficult because of extended flowering, uneven ripening, and seed shattering. Techniques as for other Panicum spp.
Suitable systems/strategies:

Mainly as a component of mixed pastures in dairy programmes.

**BLUE PANIC**
*Panicum antidotale*
Erect perennial bunch grass. Very coarse, extremely hardy.

**Adaptation:**
Altitude: To about 2200m. Frost sensitive but recovers quickly.
Rainfall: Extremely drought tolerant. Productive even with 400-500mm.
Cutting/Grazing: Extremely tolerant.

**Establishment:**
Sow on disturbed soils at low seeding rates eg. 0.5kg/ha.

**Management:**
Tolerates very heavy grazing or cutting. Try to cut regularly.

**Seed Production:** As for other *Panicum* spp.

**Suitable systems/strategies:**
Stabilisation of degraded soils. Improvement of stock exclusion areas.

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**PLICATULUM**

**Paspalum plicatulum**

Erect perennial grass, with wide range of adaptation. Hardy. Ability to colonise and spread.

**Adaptation:**
Altitude: To 2,000-2,100m. Frost sensitive, but good recovery.

Rainfall: Requires about 700mm for good production. Very tolerant of seasonal drought.


Cutting/grazing: Very tolerant.

**Establishment:**
Establishes even on very poor seedbeds. Seedlings vigorous. Sow 1-2kg/ha in mixture.

**Management/Utilization:**
Manage area to maintain legume component. Heavy cutting or grazing will not damage plicatulum, which will continue to seed and spread.
Seed Production:

Capable of quite high seed yields. Cut or graze heavily and fertilise, after each harvest. Up to 150kg/ha/harvest, 3 harvests per annum.

Suitable systems/strategies:

Some mixed pasture establishment. Very useful for improvement of exclusion areas.

MOLASSES GRASS

Melinis minutiflora

A very vigorous pioneer grass for moist, warmer areas.

Adaptation:

Altitude: To 1900-2000m.

Rainfall: Requires 900-1000mm.

Soils: Best on sandy soils and loams. Will not tolerate waterlogging.

Cutting/Grazing: Only moderately tolerant.

Establishment:

Sow as a component of pasture mixtures on well prepared seed bed. Low seeding rate eg. 1kg/ha in mixture.

Management:

Graze leniently. Molasses grass will assist in control of weeds until other components of mixture eg. Guinea grass, are better established.

Seed Production:

Seeds over a relatively short period. Seed extremely small. Cut and sweat.

Suitable systems/strategies:

Mainly as a pioneer species in mixed pastures. Also in improvement of exclusion areas on more favourable sites.

BUFFEL GRASS

Cenchrus ciliaris

An extremely hardy grass with a wide range of adaptation.

Adaptation:

Altitude: To 1900-2000m. Poor growth in cold weather. Frost tolerance only fair.

Rainfall: Extremely drought tolerant. Will persist to 250mm rainfall.

Soils: Very versatile. From sandy soils to vertisols. Most cultivars have poor tolerance of waterlogging. Prefers lighter textured soils.
Cutting/Grazing: Very tolerant.

Establishment:
Establishes readily even on rough seedbeds. Mix seed with filler such as sand to help in even spreading. Sow 1-2kg in mixture.

Management:
No special management requirements. Generally graze or cut to avoid excessive maturity, and maintain good legume content. Very persistent grass. Will spread under lenient management.

Seed Production:
Ripe seed easily identified. Can be stripped from head. Yields 40-100kg/ha/harvest with adequate N. Slash/graze heavily, then fertilise, after each harvest.

Suitable systems/strategies:
Mainly for improvement of exclusion areas. As component of mixed pastures in some lower rainfall areas.

SETARIA

Setaria sphacelata

A useful bunch type perennial grass.

Adaptation:
Altitude: To about 2300m. Some lines quite cold tolerant, and some frost tolerant.

Rainfall: Generally requires 800-900mm for good performance. Tolerant of seasonal drought.


Cutting/Grazing: Quite tolerant when well established.
Establishment :

Sow on a well prepared seedbed at 1-2kg/ha in mixture. Do not cover seed too deeply. Easily established by splits. Most lines combine well with many legumes. Lenient management usually required in first year.

Management :

Graze or cut frequently, after first year. If strip planted, manure heavily to establish continuous dense strip.

Seed Production :

Seed production relatively difficult. Yields 10-40kg/ha/harvest.

Suitable systems/strategies :

Component of mixed pastures for dairy programmes. Good for strip planting for erosion control.

Cultivars :

Kazungula extremely vigorous. May be difficult to maintain legumes. Good for altitudes to 2000m. Nandi not as vigorous, mixes better with legumes. Narok much better at higher altitudes. More cold and frost tolerant.

PHALARIS

Phalaris aquatica

A bunch type perennial grass with an extremely wide range of adaptation. Probably the most useful grass for the highlands.

Adaptation :

Altitude: Grows very well from 1700m to 3000m plus. Very cold tolerant, frost tolerant. Also tolerant of high temperatures.

Rainfall: Performs very well in higher rainfall areas. Also tolerates long seasonal droughts, and will persist in rainfalls of 400-500mm.

Soils: Versatile, but prefers heavier, fertile soils. Tolerant of flooding and waterlogging.

Cutting/grazing: Tolerant.

Establishment :

Sow on well prepared seedbed, 2-4kg/ha. Seedlings very slow initially. Establishment usually poor if early competition is great. Often better to establish Phalaris alone, if weed control is adequate, and introduce other species later. Establishment by splits convenient for strips and small plots, if seed is scarce.
Seed Production

Seed production usually low. Cultivars promoted in Ethiopia eg. Sirosa do not shatter much.

Suitable systems/strategies:

Mostly for intensive management eg. strip planting for erosion control, back yard forage in higher altitudes. Also as a component of mixed pastures.

Cultivars:

Sirosa appears very useful for many environments in Ethiopia. Better seedling vigour than most. Seed production superior. Lower levels of that alkaloid which can cause Staggers in sheep feeding on Phalaris alone.

Siro 1146 Hybrid Phalaris

A cross between P. aquatica and P. arundinacea. Sterile (produces no viable seed). Extremely vigorous, with a longer growing season than Phalaris aquatica. Where grass is to be established by splits, it is preferable to plant Hybrid Phalaris rather than Phalaris aquatica. Has the same broad agro-ecological range.

Management:

Manage leniently in first year. But control companion species by grazing/cutting if necessary. Cut or graze frequently afterwards. Try to mix Phalaris with other forages when feeding.
TALL FESCUE

Festuca arundinacea

A hardy, persistent, vigorous bunch type grass with a wide range of adaptation.

Adaptation:

Altitude: From 2000m to 3000m. Cold tolerant. Frost tolerant.

Rainfall: Will persist with only 600mm. Very productive with higher rainfall, long growing season.

Soils: Prefers fertile soils. Also productive on infertile acid soils. Tolerates waterlogging and salinity.

Cutting/Grazing: Very tolerant.

Establishment:

Sow in mixtures at about 2kg/ha. Well prepared seedbed preferred. Seedlings initially quite slow, but persistent.

Management:

Established grass very productive, tolerant of grazing and cutting. Regular grazing or cutting preferred to avoid grass becoming rank. Allow occasional seeding down.

Seed Production:

Should yield at least 100-200kg/ha/season.

Suitable system/strategies:

As component of mixed pastures in dairy programmes. Also for strip planting at higher altitudes.

COCKSFoot

Dactylis glomerata

A useful grass for well managed sites. Two distinct types exist. a) suited to high rainfall, long growing season, such as cv. Grasslands Apanui. b) suited to areas with occasional dry periods and hot weather, such as cv. Currie.

Adaptation:

Altitude: From 2000-2800/3000m. Cold tolerant, frost tolerant.

Rainfall: Down to 400-500mm.

Soils: Very versatile provided drainage is adequate.

Cutting/Grazing: Moderately tolerant.
Establishment:
Sow in mixtures at about 2kg/ha on well prepared seedbed.

Management:
Grazing/cutting management critical. If grazing/cutting too light, will form unproductive tussocks. If too heavy plants will be severely weakened.

Seed Production:
Seeds quite well in Ethiopia. Seed yields 200kg/ha plus.

Suitable systems/strategies:
Mainly for mixed pastures for dairy programmes.

RYEGRASS
Lolium spp.
Temperate grass suited mostly to the cool moist areas. Usefulness in Ethiopia has been restricted by susceptibility to rust.

Perennial Ryegrass
Lolium perenne
Suited to high fertility, well drained soils. Very high nutritive value. Extreme tolerance of cold and frost. Show a range of tolerance to seasonal droughting depending on cultivar. Perennial ryegrass is the basis of some of the world's most productive permanent temperate pastures. Extremely tolerant of grazing. Combines very well with Trifolium and Medicago spp.

Italian Ryegrass
Lolium multiflorum
Annual or biennial. Excellent growth in colder areas. Also requires high fertility soils. May be a useful short-term component of a perennial pasture mix. Usually not very persistent.

Hybrid Ryegrass
Lolium perenne x L. multiflorum
Combines persistence of perennial Ryegrass with the vigour of Italian Ryegrass. May persist for 5 yrs or more with good management.

Annual Ryegrass
Lolium rigidum
May be very productive under good fertility and good management. Will regenerate well on lighter soils, but may require soil disturbance for successful regeneration on heavier soils. Will persist in some areas to 250-300mm rainfall.
4.2.5 FODDER CROPS

FODDER BEET

Beta vulgaris

A high yielding root crop for intensive management systems.

Adaptation :

Altitude : From 1800m to 3000m.

Rainfall : Requires a long growing season; annual 750mm plus, distributed over 5-7 months. Need enough early rain for even germination.

Soils : Range of soils; avoid waterlogging; sandy soils suitable if in higher rainfall areas. Require addition of manure for good production.

Establishment :

Sow on well prepared, fine, moist seedbed. 5kg/ha. Sowing depth about 2 cm. No later than early April. Plant in rows, 40cm between rows. Thin to 20 -25cm between plants when 2 real leaves have been developed. Even out stand by transplanting if necessary.

Management and Utilization :

Control weeds, by two-three cultivations between and within rows. Beets can be harvested as needed during the dry season. (No dry matter loss from remaining in the field.) Beets must be chopped for feeding to cattle.

Seed Production:

Seed yield about 400-500kg/ha. Altitude of 2500 - 2700m suitable for seed production.

Suitable systems/strategies :

For well managed intensive plots close to dwelling or animal corral. Suited mainly to dairy production areas.
OATS

Avena sativa

A widely adaptable forage/grain crop, becoming increasingly important in Ethiopia.

Adaptation:

Altitude: Very useful from 1700m to 3000m plus. Cold/frost tolerant.

Rainfall: Down to 500mm. Good production with 800mm plus.

Soils: Grows on a wide range of soils. Will tolerate more waterlogging than most cereals, hence grown in lower parts of wet bottom land.

Cutting/grazing: Good regrowth capacity after cutting or grazing. Some lines adapted to 3 cuttings per year.

Establishment:

Sow on prepared seedbed at 70-80kg/ha. Cover seeds. Ideal for sowing with vetch (vetch at about 15kg/ha.) Sow in small rains (at onset of rains) or big rains (in July, or earlier if several harvests required.)

Management/Utilization:

Best used in cutting systems, but also suited to grazing. Try to cut or graze twice, before allowing crop to mature for final cut. (some lines particularly well suited to this.)

When sown with vetch, try to allow some vetch seed to shatter prior to final harvest. Ideal hay crop, especially when mixed with vetch.

Seed production:

Similar to other cereals. Seed yields of 10 quintals/plus.

Suitable systems/strategies:

As a forage crop (with vetch) mainly in dairy areas. Can also be used as cover crop for establishment of perennial pastures (perennial pasture species planted at same time or shortly after oats.)
# ANNEX 4.3

## SUMMARY TABLE
### MAJOR TREE/SHRUB LEGUMES

<table>
<thead>
<tr>
<th>Species</th>
<th>Altitude (metres)</th>
<th>Min. Rainfall (mm)</th>
<th>Suitable Soils</th>
<th>Frost Tolerance</th>
<th>Drought Tolerance</th>
<th>Water-logging Tolerance</th>
<th>Suitable Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leucaena</td>
<td>To 2000</td>
<td>400</td>
<td>Fertile pH6</td>
<td>Fair</td>
<td>Good</td>
<td>Poor</td>
<td>BY, FS</td>
</tr>
<tr>
<td>Sesbania</td>
<td>To 2500</td>
<td>600</td>
<td>Wide range</td>
<td>Poor</td>
<td>Fair</td>
<td>V.good</td>
<td>BY, FS</td>
</tr>
<tr>
<td>Gliricidia</td>
<td>To 1800</td>
<td>900</td>
<td>Range</td>
<td>Poor</td>
<td>Fair</td>
<td>Fair</td>
<td>BY, FS</td>
</tr>
<tr>
<td>Tree Lucerne</td>
<td>To 3000</td>
<td>300</td>
<td>Light</td>
<td>V.good</td>
<td>V.good</td>
<td>Poor</td>
<td>BY, FS, SE</td>
</tr>
<tr>
<td>Pigeon pea</td>
<td>To 2600</td>
<td>300</td>
<td>Light-Med</td>
<td>Poor</td>
<td>V.good</td>
<td>Poor</td>
<td>BY, FS, U/I</td>
</tr>
</tbody>
</table>

**BY** Back yard Forage  
**FS** Forage Strips  
**U/I** Undersowing/Intercropping  
**SE** Stock Exclusion Areas
## ANNEX 4.4

### SUMMARY TABLE

#### MAJOR HERBACEOUS LEGUMES

<table>
<thead>
<tr>
<th>Species</th>
<th>Altitude (metres)</th>
<th>Min. Rainfall (mm)</th>
<th>Suitable Soils</th>
<th>Frost Tolerance</th>
<th>Drought Tolerance</th>
<th>Waterlogging Tolerance</th>
<th>Suitable Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vetch</td>
<td>3000</td>
<td>400</td>
<td>Versatile</td>
<td>Good (except at flowering)</td>
<td>Medium</td>
<td>Medium</td>
<td>V/I, STF</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>3000</td>
<td>600</td>
<td>Deep, fertile</td>
<td>V good</td>
<td>Good</td>
<td>Poor</td>
<td>BY, STF</td>
</tr>
<tr>
<td>Lablab</td>
<td>2500</td>
<td>400</td>
<td>Versatile</td>
<td>Medium</td>
<td>Good</td>
<td>Poor</td>
<td>BY, STF</td>
</tr>
<tr>
<td>Cowpea'</td>
<td>2500</td>
<td>300</td>
<td>Versatile</td>
<td>Medium</td>
<td>Good</td>
<td>Poor</td>
<td>U/I, MP, SE, FS</td>
</tr>
<tr>
<td>Greenleaf</td>
<td>2300</td>
<td>700</td>
<td>Versatile, more fertile</td>
<td>Medium</td>
<td>Good</td>
<td>Poor</td>
<td>U/I, MP, SE</td>
</tr>
<tr>
<td>Desmodium</td>
<td>2100</td>
<td>500</td>
<td>Versatile, lighter</td>
<td>Medium</td>
<td>Good</td>
<td>Medium</td>
<td>SE, O, U/I, MP</td>
</tr>
<tr>
<td>Siratro</td>
<td>2200</td>
<td>500</td>
<td>Versatile</td>
<td>Poor</td>
<td>Good</td>
<td>Medium</td>
<td>SE, O, U/I, P</td>
</tr>
<tr>
<td>Axillaris</td>
<td>1800</td>
<td>700</td>
<td>Versatile</td>
<td>Poor</td>
<td>Medium</td>
<td>Medium</td>
<td>SE, O</td>
</tr>
<tr>
<td>Calopo</td>
<td>2300</td>
<td>600</td>
<td>Versatile, fertile</td>
<td>Medium</td>
<td>Good</td>
<td>Poor</td>
<td>U/I, MP</td>
</tr>
<tr>
<td>Glycine</td>
<td>2200</td>
<td>500</td>
<td>Light-Med</td>
<td>Poor</td>
<td>Good</td>
<td>Poor</td>
<td>O, SE, MP, U/I</td>
</tr>
<tr>
<td>Verano stylo</td>
<td>2000</td>
<td>500</td>
<td>Light-Med</td>
<td>Poor</td>
<td>V. good</td>
<td>Poor</td>
<td>O, SE</td>
</tr>
<tr>
<td>Seca stylo</td>
<td>2000</td>
<td>500</td>
<td>Light-Med</td>
<td>Poor</td>
<td>Medium</td>
<td>Medium</td>
<td>SE, MP</td>
</tr>
<tr>
<td>Graham stylo</td>
<td>2000</td>
<td>500</td>
<td>Light-Med</td>
<td>Poor</td>
<td>Medium-Moderate</td>
<td>Medium</td>
<td>SE, O, U/I, P</td>
</tr>
<tr>
<td>Cassia</td>
<td>2300</td>
<td>400</td>
<td>Versatile</td>
<td>Medium</td>
<td>V. good</td>
<td>Medium</td>
<td>SE, O, U/I, MP</td>
</tr>
<tr>
<td>Lotiononis</td>
<td>2600</td>
<td>800</td>
<td>Versatile</td>
<td>Good</td>
<td>Medium</td>
<td>V. good</td>
<td>MP, O, SE</td>
</tr>
<tr>
<td>Trifolium spp</td>
<td>3000</td>
<td>300</td>
<td>Variable</td>
<td>Good</td>
<td>Variable</td>
<td>Variable</td>
<td>MP, U/I</td>
</tr>
<tr>
<td>Pigeon Pea</td>
<td>2700</td>
<td>200</td>
<td>Light-Med</td>
<td>Poor</td>
<td>V. good</td>
<td>Poor</td>
<td>U/I, FS, BY</td>
</tr>
</tbody>
</table>

- **BY** Backyard Forage
- **FS** Forage strips
- **U/I** Undersowing/Intercropping
- **O** Oversowing
- **STF** Short-term Forage Crops
- **MP** Mixed Pastures
- **SE** Stock Exclusion Areas
## SUMMARY TABLE

### GRASS SPECIES AND FODDER CROPS

<table>
<thead>
<tr>
<th>1. Grass species</th>
<th>Altitude (metres)</th>
<th>Min. Rainfall (mm)</th>
<th>Suitable Soils</th>
<th>Frost Tolerance</th>
<th>Drought Tolerance</th>
<th>Water-logging Tolerance</th>
<th>Suitable Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elephant</td>
<td>2500</td>
<td>800</td>
<td>Versatile</td>
<td>Medium</td>
<td>Good</td>
<td>Poor</td>
<td>BY, FS</td>
</tr>
<tr>
<td>Phodes</td>
<td>2400</td>
<td>500 - 600</td>
<td>Very versatile</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>MP, SE</td>
</tr>
<tr>
<td>Guinea</td>
<td>2000</td>
<td>900</td>
<td>Versatile</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>BY, FS</td>
</tr>
<tr>
<td>Gatton Panic</td>
<td>2200</td>
<td>900</td>
<td>Versatile</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>MP, BY</td>
</tr>
<tr>
<td>Green Panic</td>
<td>2200</td>
<td>500</td>
<td>Versatile</td>
<td>Medium</td>
<td>Good</td>
<td>Medium</td>
<td>MP</td>
</tr>
<tr>
<td>Bambatsi Panic</td>
<td>2400</td>
<td>400</td>
<td>Versatile</td>
<td>Good</td>
<td>V. good</td>
<td>V. good</td>
<td>MP</td>
</tr>
<tr>
<td>Plicatulum</td>
<td>2100</td>
<td>700</td>
<td>Light</td>
<td>Poor</td>
<td>Medium</td>
<td>V. good</td>
<td>SE</td>
</tr>
<tr>
<td>Buffel grass</td>
<td>2100</td>
<td>250</td>
<td>Versatile</td>
<td>Medium</td>
<td>V. good</td>
<td>Poor</td>
<td>SE, MP</td>
</tr>
<tr>
<td>Setaria-Kazungula</td>
<td>2000</td>
<td>800</td>
<td>Versatile, light</td>
<td>Medium</td>
<td>Medium</td>
<td>Good</td>
<td>MP, FS</td>
</tr>
<tr>
<td>Setaria-Narok</td>
<td>2300</td>
<td>800</td>
<td>Versatile, light</td>
<td>Medium</td>
<td>Medium</td>
<td>Good</td>
<td>MP, FS</td>
</tr>
<tr>
<td>Phalaris</td>
<td>3000 plus</td>
<td>400</td>
<td>Heavier, fertile</td>
<td>V. good</td>
<td>Good</td>
<td>V. good</td>
<td>MP, BS</td>
</tr>
<tr>
<td>Tall Fescue</td>
<td>3000</td>
<td>600</td>
<td>Versatile</td>
<td>V. good</td>
<td>Medium</td>
<td>Good</td>
<td>MP</td>
</tr>
<tr>
<td>Cocksfoot</td>
<td>3000</td>
<td>500</td>
<td>Versatile</td>
<td>V. good</td>
<td>Good</td>
<td>Poor-Medium</td>
<td>MP</td>
</tr>
<tr>
<td>2. Fodder Crops</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oats/vetch</td>
<td>1800-3000</td>
<td>600 - 800</td>
<td>Versatile</td>
<td>Medium</td>
<td>Medium</td>
<td>Good</td>
<td>STF</td>
</tr>
<tr>
<td>Fodder beet</td>
<td>1800-3000</td>
<td>750</td>
<td>Versatile</td>
<td>V. good</td>
<td>V. good</td>
<td>Poor</td>
<td>STF</td>
</tr>
</tbody>
</table>

BY = Backyard forage  FS = Forage strips  U/I = Undersowing/Intercropping  SE = Stock Exclusion Areas  O = Oversowing  STF = Short term forage crops  MP = Mixed Pastures
## Annex 4.6

### Undersown Legumes

#### Seeding Rates and Major Characteristics

<table>
<thead>
<tr>
<th>Species</th>
<th>Seeding Rate</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vetch</td>
<td>12kgs/ha, 80gms/100m of row</td>
<td>Vigorous, heavy seeding, self regenerating</td>
</tr>
<tr>
<td>Cowpeas</td>
<td>12kgs/ha, 80gms/100m of row</td>
<td>Vigorous, quick maturing, good seed production. Re-sow annually</td>
</tr>
<tr>
<td>Lablab</td>
<td>15kgs/ha, 100gms/100m of row</td>
<td>Vigorous, quick maturing, good seed production. Re-sow annually</td>
</tr>
<tr>
<td>Desmodium spp</td>
<td>1kg/ha, 8gms/100m of row</td>
<td>Slow initially, relatively slow to set seed. Good regeneration from seed.</td>
</tr>
<tr>
<td>Siratro</td>
<td>2kgs/ha, 15gms/100m of row</td>
<td>Moderately fast seeding, seeds heavily, high proportion of hard seed.</td>
</tr>
<tr>
<td>Axillaris</td>
<td>2kgs/ha, 15gms/100m of row</td>
<td>Moderately fast seeding, seeds more lightly than siratro, and later than siratro. Good regeneration from seed.</td>
</tr>
<tr>
<td>Cassia rotundifolia</td>
<td>3kgs/ha, 20gms/100 of row</td>
<td>Slow seedling, not vigorous at any stage. Seeds heavily. Good regeneration from seeds.</td>
</tr>
<tr>
<td>Stylo (Graham, Verano)</td>
<td>3kgs/ha, 20gms/100m of row</td>
<td>Slow seedling. Variable vigour of older plants. Usually seed heavily. Good regeneration from seed. Graham more productive. Verano more reliable in seed production.</td>
</tr>
</tbody>
</table>
## FORAGE ACTIVITY CALENDAR

<table>
<thead>
<tr>
<th>Activity</th>
<th>JAN</th>
<th>FEB</th>
<th>MAR</th>
<th>APR</th>
<th>MAY</th>
<th>JUNE</th>
<th>JULY</th>
<th>AUG</th>
<th>SEP</th>
<th>OCT</th>
<th>NOV</th>
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<tr>
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</tr>
<tr>
<td>Monomodal</td>
<td></td>
<td></td>
<td></td>
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<td>Bimodal</td>
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<td><strong>EXTENSION</strong></td>
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</tr>
<tr>
<td>Identification of new SCs</td>
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</tr>
<tr>
<td>Initial Extension for New SCs</td>
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